SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MAY 1912.

GENERAL PHYSICS.

628. *A High-speed Fatigue-tester and the Endurance of Metals under Alternating Stress of High Frequency.* **B. Hopkinson.** (Roy. Soc., Proc. Ser. A. 86. pp. 131-149, Jan. 31, 1912.)—Numerous tests in fluctuating and alternating stress have been made at speeds up to 2000 cycles per minute. They all agree that the algebraic range of stress determines failure, and, in spite of considerable differences, the weight of evidence shows that, at these speeds, the rate of application has no effect on the endurance of metals. The author suggests that if this independence continues to hold, much time could be saved by running at higher speeds. He has devised a machine to give alternating stress-cyles at 6000 and more per min. The cylindrical specimen is suitably attached at one end to a heavy concrete base. The other end is loaded with a weight of about 180 lbs. and is attached to a laminated armature. Any desired steady tension may be applied by means of a screw working in the frame and attached through a spring balance to the armature. Separated from the armature by a short air-space is an electromagnet excited by alternating current. The armature is thus subjected to a magnetic pull varying from zero to a maximum with a frequency twice that of the e.m.f.; its amount is determined by measuring the flux density with a search coil. The test-piece acts as a spring with one end fixed and the other loaded. By bringing the magnetic period nearly into resonance with the natural period of this system, forced vibrations are set up in the latter which greatly magnify the magnetic force and subject the piece to alternating stress. The mean tensile stress due to the magnetic force is small compared with the vibrational forces and is practically counteracted by the load of 180 lbs. on the armature. Strains in the specimen are measured by a mirror extensometer which throws on a screen a sharply defined band representing the movement of the image of a stationary filament. The stresses may be deduced from the strains by means of E determined in a static test, if stresses are within the elastic limit. In the present case they are probably extra-elastic. To test this point the forces were calculated from the accelerations of the armature. The latter were measured by observing the band of light reflected from a lamp by a needle attached to the weight below the armature, and calculating the acceleration from the amplitude on the assumption of simple harmonic motion—an assumption which is justified. The results of comparative tests are given, and show that the stress calculated from extension is on the average about ¾ ton per sq. in. higher than the true stress. The loss is due to hysteresis, the specimen becoming warm. A number of tests are recorded, made at high speeds in the Hopkinson machine and at lower speeds in the National Physical Laboratory machines. The results show that the life of a specimen, both in number of cycles and of time, is not appreciably altered in changing from 1100 to 2000 r.p.m. But at 7000 cycles per min. the endurance in both respects is greater to a marked degree. There is no proof, however, that the limiting range, at which an infinite number of reversals will not cause failure, is higher. The author concludes with some observations on the causes of speed-effect. Fatigue is the cumulative effect of internal slips. Higher speed reduces the time available for this cyclical permanent set and increases endurance. Fatigue is opposed by recovery which is, of course, more complete at low speeds. Hence endurance, in this light, is higher at low speeds. The total effect is to make the endurance fall with speed to a very flat minimum and then to rise again. If recovery effect is small the endurance may be sensibly constant at low speeds. C. A. M. S.

629. *Torsion Experiments on Bodies of Rectangular Cross-section.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 440–441, March 16, 1912.)—The work of St. Venant led to the conclusion that the stress in a rectangular prism under pure torsion would be greatest at the mid points of the long sides of the cross-section, *i.e.*, along those generators lying nearest to the axis. In experiments on cast iron the fracture is so sudden that the region of initial failure cannot be determined with certainty. In some experiments made by the author on ferro-concrete prisms of rectangular section the fracture is seen to begin at the middle of the broad faces. Twelve diagrams show the form of the specimens and the manner in which the fracture begins. H. S. R.

630. *Bending Tests on Cast-iron Bars.* **R. Schöttler.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 851–857, March 2, and pp. 884–890, March 9, 1912.)—It has been known for many years that the tensile strength of cast iron as calculated from bending tests is apparently higher than that found from pure tension. It is suggested that the discrepancy is caused by the influence of shear stresses, and Bach devised a formula to give the true stresses set up. The author rejects this, since it is founded on breaking tests, where the stresses are far beyond the elastic limit. He describes a number of tests on cast iron of various sections as well as on cast steel, wrought iron, and Mannesmann tubes. The stress-strain curves for tension and compression are shown for all the materials, E being calculated from each. A large number of bending tests were made, using a Bauschinger mirror apparatus to measure the strains in the outer fibres of the beams. The stresses can be calculated, knowing E, from the observed strains. The value of E can be calculated from the observed deflection, allowance being made for flexure due to shear, and checked against the modulus found by direct loading. The cast iron, though all from one pot and in only two castings, showed 14 per cent. variation in the value of the modulus. E was therefore determined for each beam from specimens cut from the same after the bending tests were finished. For cast steel, wrought iron, and Mannesmann tubes, strains are proportional to loads but are somewhat smaller on the compression than on the tension side. But the actual stresses are greater than the theoretical ones, the differences being 7 per cent. for wrought iron, 5 per cent. for cast steel, and 14 per cent. for the tubes. The stresses calculated from observed reflections are too small. These conclusions require further practical confirmation. All the cast-iron beams were tested in bending to a stress not exceeding 300 kg./cm.^{2}. Half of these were then used to determine E, the others being further bent up to 550 kg./cm.^{2} stress and finally broken. Since E often varied for two exactly similar specimens, the calculated deflections and the conclusions based on observed deflections are of doubtful value. But the strains may be taken as accurate, though the stresses may not. The deflections for cast iron increase more quickly than the loads owing to the progressive decrease of the modulus. The variation agrees fairly with theory. At the higher loads beams of more solid section seem to deflect more rapidly, and beams of lighter section more slowly, than the stress-strain curves would suggest; but this cannot definitely be concluded. The influence of shear on deflection is small at the higher spans, but is appreciable at spans under 120 cm. The results show that the form of section seems to have little influence on the stress-strain relation for cast iron. There is no great difference between observed and calculated stresses except for the tubular section. In this case at 40 cm. span the observed stresses were only about 60 per cent. of the calculated. The stress-distribution over this section is probably far from linear. The stresses calculated from the higher loadings are of uncertain value, but serve to show that, while rupture is still far off, the theoretical bending stress is not greater than the direct stress in the ratio B : Z, where B = bending moment for rupture, Z = ultimate strength. The variation is much less and is irregular. Breaking tests confirmed Bach's conclusion that the "breaking strength" is greater than the direct strength. The tests did not, however, confirm Bach's conclusion that the ratio of the strengths is greater the nearer the elements of the section lie to the neutral plane. The actual form of the elastic curve assumed by the beam was determined by measuring deflections simultaneously at several points. The curve is slightly less steep than the theoretical line. The author concludes that bending tests of cast iron to destruction are misleading. Strain measurements should be made; E should be determined by the most accurate methods, and stresses calculated from these observations. C. A. M. S.

631. *Gravitation.* **A. C. Crehore.** (Electrical World, 59. pp. 413–415, Feb. 24, 1912.)—Following up his preceding paper [Abstract No. 487 (1912)], the author gives a proof, based directly on the general solution given by J. J. Thomson (*Phil. Mag.*, 1881), that it is entirely possible and even probable that the force upon a revolving negative corpuscle is negligible, as was assumed in the former paper, provided that the angular velocities of the corpuscles within the two atoms are about the same, probably approaching the velocity of light. It will be of importance to determine the positions and velocities of the corpuscles and the exact description of the fields surrounding them at the approximate velocity of light. A. D.

632. *Energy and Mass.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 822–824, Feb. 22, 1912.)—Discusses the variation of mass with energy, and asserts that if it be postulated that mass varies in the way expressed by $m = W/c^2$, then the whole theory of relativity may be derived from the classic mechanics with that one modification as to mass. [See Abstracts Nos. 434 (1908), 1368 (1911), and 29 (1912).] E. H. B.

633. *Constitution of the Atom.* **H. A. Wilson.** (Amer. Phil. Soc., Proc. 50. pp. 366–373, July–Aug., 1911.)—According to the theory of J. J. Thomson atoms may be regarded as rigid spheres of positive electricity containing negative electrons which can move about freely through the positive charge. The total negative charge on the electrons in the atom is equal to the positive charge on the sphere. Further, according to this theory the properties of different atoms are due to the number and arrangement of the electrons in the positive sphere. The problem of the distribution of n electrons in a positive sphere is very complicated, so J. J. Thomson investigated the simpler problem of the distribution of n electrons in a plane when they are all acted on by forces of attraction proportional to their distances from a fixed point in the plane. He also suggested that each element in a series may be derived from the one before it by the addition of another ring of electrons, the arrangement of the inner rings remaining unchanged.

The present author now works out an approximate solution in three dimensions, in which the positive sphere is divided up into n equal volumes, all as nearly spherical as possible, and an electron is put at the centre of each of the n volumes. When n is large this requires that the electrons be arranged like the centres of the shot in a pile of shot. The author thus finds that the cube roots of the atomic weights of neighbouring elements in a series differ by a constant which is 0·81 nearly, or, in symbols, $A_{m+1}^{1/3} - A_m^{1/3} = C$. Also on this theory, the number of electrons per atom comes out *eight* times the atomic weight in all cases. The following comparisons are given between the experimental and calculated atomic weights ;—

Elements…………………		H	Li	Na	K	Rb	Cs	Be	Mg	Ca	Sr	Ba	Ra
Atomic Weights	Actual …	1	7	23	39	85	133	9	24	40	87	137	226
	Calculated .	1	6	18	40	77	129	9	24	51	92	150	230

[See Abstract No. 1320 (1911).] E. H. B.

634. *Transpiration of Air through Water.* **C. Barus.** (Amer. Phil. Soc., Proc. 50. pp. 117–124, Jan.–April, 1911.)—The author observed that the Cartesian diver used in his lectures grew heavier from year to year, so judged that the slight excess pressure of the imprisoned air must be driving it out through the water. By observation, over a number of years, of a special Cartesian diver, the conclusion was reached that the air escapes as though moving through a liquid about twice as viscous as the air itself. E. H. B.

635. *Viscosities of Gaseous Chlorine and Bromine.* **A. O. Rankine.** (Roy. Soc., Proc. Ser. A. 86. pp. 162–168, Feb. 20, 1912.)—The measurements were made with a modified form of the author's apparatus [see Abstract No. 649 (1910)]. The absolute values of the viscosities are : for Cl (12·7°), 1·297 ; Cl (99·1°), 1·688 ; Br (98·7°), 1·869 ; all multiplied by 10^{-4}. [See also Abstract No. 888 (1910).] L. H. W.

636. *Kinetic Theory of Gas formed of Spherical Molecules.* **S. Chapman.** (Roy. Soc., Phil. Trans. 211. pp. 433–483, March 9, 1912.)—The principal kinetic theories of a gas proceed either on the hypothesis that the molecules are elastic spheres, or that they are point centres of force which vary inversely

as the fifth power of the distance. Maxwell has worked out the consequences of the latter hypothesis in his well-known theory. The other hypothesis has been worked out by a method originally devised by Clausius and Maxwell. But Maxwell abandoned it later, as it had "led him at times into grave error." The present paper develops the latter methods, with an extension of the analysis to the elastic-sphere theory among others. Expressions are thus obtained for the viscosity, diffusivity, and conductivity of a gas without assuming any properties of the molecules save that they are spherically symmetrical. E. H. B.

637. *Oscillatory and Uniform Motion of Liquids in Tubes. Internal Friction.* **M. Menneret.** (Annales de la Faculté de Grenoble, May, 1911. Journ. de Physique, 1. Ser. 5. pp. 758–766, Sept., and pp. 797–804, Oct., 1911.)—The author has examined (*a*) the oscillations of various liquids in U-tubes, and (*b*) the uniform flow of liquid through a horizontal tube. It is found that there are two states of oscillation under the conditions of (*a*), analogous to the two states in uniform flow. The formula deduced to express the results obtained under (*b*) gives values which are in good accord with those of Couette, and of Bossut; also with the formulæ of Levy, Hagen, and Reynolds. **Boussinesq** (Ibid. pp. 793–797, Oct., 1911) comments on the above. L. H. W.

638. *The Phenomena of Splashes.* **A. M. Worthington.** (Engineering, 93. pp. 223–224, Feb. 16, 1912. Abstract of lectures delivered at the Royal Inst., Feb. 1 and 8, 1912.)—The very complex splash phenomena produced when water or milk drops into water or milk, or *vice versa*, and when marbles or balls of steel, polished or rough on the surface, are dropped into water are photographed by the author in the following way, because the ordinary kinematograph would be far too slow for this purpose. A succession of splashes is produced, all the drops falling from the same height and passing through the same phenomena; the first drop is photographed when it touches the surface, the drop being illuminated by a spark at that instant; the second photograph is taken with a second drop, a few thousandths of a second later, and so on. Thus a series of photographs is secured with different drops, the time intervals increasing by a small definite amount. The spark is produced by letting a brass ball fall through a spark-gap, and the height of fall of this spark ball is increased to lengthen the time interval. This spark does not photograph, however; the illuminating spark is produced in a dark-room on a secondary circuit. The varied phenomena are chiefly due to surface tension and to the formation of a film of liquid on the surface of the body entering the liquid; when the surface of the body is perfectly smooth the film coheres, when rough it leaves the body. Hence the differences between rough and polished spheres which differences vanish, however, when a certain height of fall (or velocity) is exceeded. The theory rests partly on J. A. F. Plateau's researches (1873) that an isolated cylindrical rod or ring of liquid is not stable if of greater length than its circumference and that it will in such a case topple into a series of drops when left to itself. H. B.

639. *Experimental Study of Vortex Motions in Liquids.* **E. F. Northrup.** (Frank. Inst., Journ. 172. pp. 211–226, Sept., and pp. 345–368, Oct., 1911. Nature, 88. pp. 463–468, Feb. 1, 1912. Abstract.)—The author has examined the various properties of single and double rings, both visually and with the aid of the camera. A tank of plate glass was constructed which would permit of the rings being observed from either side, the top, and one end.

For the production of the rings a cylindrical metal can (termed a "gun") was used, of diam. 7·7 cm. and axial length 6·6 cm. One end of the can was provided with a flexible diaphragm of phosphor bronze, which could be struck suddenly by the plunger of an electromagnet. The other end could be closed with metal discs, which were provided with one or more holes of various shapes and dimensions. For the production of a single ring one hole in the centre of the disc was used 1 cm. in diam. To make the rings visible the water in the can was made strongly alkaline and coloured with phenolphthalein, and the water in the tank was made slightly acid; with the result that the projected rings were of a deep red colour, and entirely disappeared on breaking up. The original pages should be referred to for details and the numerous photographs given. The following points may, however, be mentioned:—The motion of the rings through the water is rapid (about 2 m. per sec.). A light watch-chain hung in the water if struck by a ring is bent into a curve by the force of the blow; but a ring will pass through a piece of chiffon without breaking up. Reflection of rings from the surface was observed, also refraction when passing from a layer of greater density to one of less. Of special interest is the behaviour when the water in the tank is covered with a layer of kerosene from 5 to 10 cm. deep (the oil being coloured with Soudan III.). When the gun is filled with uncoloured water, and is located a few centimetres below the surface of the oil, and an invisible ring is projected at a suitable angle with the surface of the oil, it enters the oil, and is instantly converted into an oil ring which proceeds to the upper surface of the oil; it is there reflected and re-enters the water as a visible oil ring, which proceeds with only slightly diminished velocity for a metre or more through the water. After the ring breaks up the oil rises to the surface of the water, and after the surface has been quitted another ring may be produced, and the process may be continued indefinitely. As the water is uncoloured, the illusion is produced of red oil rings issuing from the oil without any apparent agency for their production. Experiments were also conducted which demonstrated that in the case of two liquids of different densities—at least if these two liquids are not miscible—it is possible to project a ring of the less dense liquid through the liquid of greater density, but it is not possible to project a vortex ring of the liquid of greater density through the liquid of less density. Thus a ring of kerosene oil can be projected through water, but a ring of carbon tetrachloride cannot. By projecting rings of liquid paraffin through hot water, and thence into an underneath stratum of cold water, very pretty solid rings of paraffin were obtained and preserved. L. H. W.

640. *Development of Barometric Depressions in High Latitudes.* **F. M. Exner.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1411–1484, Nov., 1911.)—In 1888 v. Helmholtz sketched a theory of barometric depressions in high latitudes by regarding areas of high and low pressure as produced by the conflict of the great polar and equatorial currents taking part in the general circulation of the atmosphere. Air over a pole sinks and flows towards the equator. At the same time it is deflected towards the W. by the effect of the earth's rotation, so that the motion of this cold air in high latitudes is observed in the northern hemisphere as a NE. wind. To supply the place of the air removed from over the pole, warm air drawn from the equator flows north. This air is apparent as a SW. wind at the surface, since it is deflected towards the E. on account of the earth's rotation. It is a warm current; therefore it passes over the cold NE. wind and descends at the pole. Ideally, over an area surrounding the pole would be a mass of cold air moving from the NE., while above it would be the warm air from SW. flowing polewards, to become in turn the cold current. Helmholtz stated that on account of surface irregularities, and since the geographical pole does not coincide with the pole of cold, the actual conditions would be irregular, and that the formation of isolated "highs" and "lows" would take place at the surface, instead of a large surface anticyclonic circulation round the pole, with a cyclonic circulation above it, as the simple theory suggests. The above process if once started would not continue for long, except for the frictional effect of the earth's surface, which prevents equilibrium from being attained and tends to maintain the circulatory motion. The author applies formulæ of Margules for finding the characteristics of the boundary between the two currents and for determining the total energy of a column of air, to find how much kinetic energy is produced per hour in the ideal case of Helmholtz, the energy being converted from potential energy by the frictional effects alluded to. As an example of his theoretical result he shows that if the cold wind has an E. component of 5 m./sec., and the warm wind a W. component of 10 m./sec., and if the temperature difference is 10° C., the kinetic energy of the circulatory motion above described is such as to give each particle of air a velocity of 1 m./sec. on the average, assuming that K, the coefficient of friction, is 10^{-4} c.g.s. This velocity represents the mean rate of exchange between the NE. and SW. currents, and is not necessarily the velocity of any particular particle of air. At a place where K is greater (the east coast of Greenland is suggested as such a one) the velocity would be correspondingly increased, and to this, it is suggested, is due the permanent North Atlantic low-pressure system.

R. C.

641. *Investigation of the Upper Atmosphere.* (Nature, 88. pp. 161–162, Nov. 30, 1911. From the 10th Report of a British Assoc. Committee, Portsmouth, 1911.)—Thirty-one registering balloons were sent up in the British Isles during the international week, Aug. 7 to 13, 1910; some also in Ireland from Limerick (Mungret College) and Oughterard. The curves obtained agree in their general features; there is a steady fall of temperature up to about 12 km., when there is little further change or a rise again (by 5° and 6° C.). In July, 1911, a height of 21 km. was reached from Limerick, and a minimum temperature of 216° abs. was registered at 12·7 km.; other minima, all at about heights of 12 km., were 212 and 213° abs. The rubber balloons used are not suitable for the climate of Barbados. H. B.

642. *Relation between Changes of the Weather and Local Phenomena.* **J. P. van der Stok and P. H. Gallé.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 856–865, March 28, 1912.)—This paper represents an attempt to investigate mathematically the effect of a changing pressure-gradient on the associated wind currents. It was made with a view to determine whether the large deviations from normal values of the wind velocity and incurvature which are sometimes met with on synoptic charts may give evidence of some definite changes in the gradient which are taking place at the time. One or two simple types of change of gradient are first referred to, and the authors then pass on to a consideration of the equations of motion for an air-particle in the case when the variation in intensity of the gradient can be represented by the function e^{ant} of the time t, and the variation in the direction of the gradient by a uniform rotation with angular velocity sn, where n is the angular velocity of the earth and q and s are variable parameters. Under these assumptions the equations lead to simple solutions for the wind velocity v and the deviation of wind direction from the line of gradient a. The values of v and a obtained when q and s are zero, that is when the gradient is steady, are defined as normal values (v_0 and a_0), and tables are given showing the values of v/v_0 and $a - a_0$ for different values of q and s. (The values of v/v_0 and $a - a_0$ are independent of the time t.) These tables lead to various conclusions of which the following is an example: "A wind velocity greater than the normal value generally indicates a decreasing gradient and veering wind, and is often associated with abnormally large angles of deviation." The probable movements of depressions which are associated with different changes in the gradient are then discussed, and the authors point out that the rules thus deduced for weather forecasting correspond for the greater part with the rules advocated by Guilbert and deduced empirically. In order to test the method in a practical manner a series of weather maps was taken. Each map was divided up into compartments, and in each compartment the anticipated change of pressure in 24 hours based on the observed local symptoms was noted. These changes of pressure were compared with the observed changes, and the percentage of success achieved was found to be on the average about 70, where, of course, 100 represented complete success and 0 complete failure. A further and more rigorous test was applied by considering one station only, the observed wind at that station being considered in relation to the gradient deduced from three neighbouring stations. In this case the average success obtained was 65·4 per cent. The method was also found to be very successful when applied to the signalling of storms. J. S. Di.

643. *Velocity of Transverse Seismic Waves near the Earth's Surface.* **H. Benndorf.** (Phys. Zeitschr. 13. pp. 83–84, Jan. 15, 1912.)—When a longitudinal wave arrives at the earth's surface it causes a reflected transverse wave, the velocity of propagation, v, of which is related to the apparent surface velocity V of the longitudinal wave as indicated by the equation $V \sin i = v$, where i is the angle of incidence of the oncoming wave. i is obtained from the horizontal and vertical displacements of the ground as recorded by Galitzin seismographs, and hence v is determined. Some results are given in the paper. A. D. R.

644. *A Relation between Tension and Torsion.* **R. A. Houstoun.** (Phil. Mag. 22. pp. 740–741, Nov., 1911.)

645. *Internal, Molecular, or Intrinsic Pressure—a Survey of the Various Expressions proposed for its Determination.* **W. C. McC. Lewis.** (Faraday Soc., Trans. 7. pp. 94–115, Nov., 1911.)

646. *The Pressure of a Blow.* **B. Hopkinson.** (Nature, 88. pp. 531–536, Feb. 15, 1912. Discourse delivered at the Royal Inst., Jan. 26, 1912.)

647. *Relativity Theory.* **M. Laue.** (Phys. Zeitschr. 13. pp. 118–120, Feb. 1, 1912.)—Discusses objections to the relativity theory and replies to them. E. H. B.

648. *Conversion of Kinetic to Pressure Energy in the Flow of Water through Passages having Divergent Boundaries.* **A. H. Gibson.** (Engineering, 93.

pp. 205–206, Feb. 16, 1912.)—Deals with the results of the author's experimental work [Abstract No. 1426 (1911)] in so far as it is likely to directly affect hydraulic design.

649. *Relativity Principle in Ether Hypothesis.* **G. Helm.** (Phys. Zeitschr. 13. pp. 157–158, Feb. 15, 1912.)—Maintains that a thoroughgoing hypothesis of the ether is only possible on the relativity principle. E. H. B.

650. *Some General Theorems in Mechanics and Thermodynamics.* **L. Bloch.** (Journ. de Physique, 1. Ser. 5. pp. 912–922, Nov., and pp. 988–996, Dec., 1911.)—Unsuitable for abstraction.

651. *Internal Friction of Gas Mixtures.* **E. Thomsen.** (Ann. d. Physik, 36. 4. pp. 815–833, Dec. 7, 1911. Extract of Dissertation, Kiel.)—An experimental investigation of the internal friction of various gas mixtures has established the qualitative validity of the Puluj formula in all cases, but quantitatively it only gives approximate results. [See also Abstract No. 1844 (1906).] A. W.

652. *Meteorological Observations in Moscow,* 1910. **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 24. 4. pp. 510–552, 1910.)—Consists mainly of tabulated data.

653. *The Age of the Earth.* **T. H. Laby.** (Nature, 88. pp. 334–336, Jan. 4, 1912. Part of presidential address to the Australian Assoc. for Advancement of Science, 1911.)

654. *Brisbane Tidal Records for* 1908. **F. J. Selby.** (Roy. Soc., Proc. Ser. A. 86. pp. 64–66, Dec. 22, 1911.)—The paper gives the results of an analysis of the tidal records for Brisbane for 1908, carried out at the National Physical Laboratory. The data were obtained from a recording tide gauge at the Pile Lighthouse in Moreton Bay on the outer edge of the bar of Brisbane River. The reductions were carried out on the system formulated by G. H. Darwin. C. P. B.

655. *Auroral Streamers and Atmospheric Absorption.* **P. Lenard.** (Akad. Wiss. Heidelberg, Ber. No. 17. 1910, and No. 12, 1911. Meteorolog. Zeitschr. 28. pp. 481–487, Nov., 1911. Extract.)—Taking Störmer's values of the heights of occurrence of auroral streamers, their variation of absorption by the atmosphere is examined. C. P. B.

656. *Position of Encke's Comet* (1911*d*). **Backlund.** (Astronom. Nachr. No. 4539. Nature, 88. pp. 225–226, Dec. 14, 1911. Abstract.)—The observed and calculated places of the comet for the 1911 apparition are tabulated with special reference to the investigation of the acceleration. C. P. B.

657. *Luminosities and Radii of Stars.* **J. B. Cannon.** (Roy. Astronom. Soc., Canada, Journ. 5. No. 5. Nature, 88. p. 259, Dec. 21, 1911. Abstract.)—This paper is an attempt to give comparative sizes and albedoes for typical stars of the various spectral classes of Pickering's groups. C. P. B.

LIGHT.

658. *A New Binocular Photometer.* **R. Stigler.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1069–1078, July, 1911.)—The author has found that by binocular vision a smaller percentage change in brightness can be detected than by the use of only one eye. However, the degree of precision reached by ordinary photometers suffices for practical purposes. A more important advantage of binocular vision is that it enables photometer-readings to be made more quickly and with less fatigue, and it also minimises possible differences between the perception of the right and left eyes of observers. The author has devised a photometer based on the binocular principle. A magnesia screen is illuminated by the sources to be compared, one on each side in the usual way. The rays diffusely reflected from the respective sides of the screen are collected by two concave mirrors and directed on the faces of two prisms separated by a fine dividing edge. There are two apertures, for the left and right eye respectively, both eyes receiving a complete view of the illuminated field. In conclusion, some figures are given showing the mean of a number of experiments with the photometer, using respectively the right eye, the left eye, and both eyes, a material improvement in ease and precision being obtained in the latter case. J. S. D.

659. *A Displacement Interferometer adapted for High-temperature Measurement, Adiabatic Transformations of a Gas, &c.* **C. Barus.** (Amer. Journ. Sci. 33. pp. 109–119, Feb., 1912. Abstract from Report to the Carnegie Inst. of Washington.)—With elliptic interferences, interferometry by displacement has an advantage inasmuch as the observer never loses the ellipses, even when the displacement is sudden. Their centre may always be brought back again to a given spectrum line by the micrometer. Moreover, the sensitiveness may be regulated by decreasing the thickness of the grating e, by aid of a compensator of thickness e', for the virtual thickness is now $e - e'$. Since for radial motion the sensitiveness per fringe across any given Fraunhofer line is $dN/dn = \lambda/2$, the two controls can be combined in any ratio, the limit of the procedure being dependent on the size of the ellipses or the available size of the field of the telescope, since when $e - e'$ approaches zero the ellipses become enormous. Finally, if ΔN is the motion of the micrometer to bring the centre of the ellipses back to a given line, $\Delta N = (\mu - 1)e'$. If e' is large, we may expect to distinguish between the indices of refraction of a birefringent crystal for polarised light. Again, when the arms or the interfering beams of light are long, the refraction of a gas and its relation to temperature and pressure are determinable. In view of these advantages among others, the author has constructed a form of apparatus for displacement interferometry, specially adapted for general observations, such as those on fog particles. It is to be light, portable, rigid, with relatively long distance between the centre and remote mirrors, and with easy adjustment for different angles of incidence. The long arms and feet of the apparatus, which in general form is naturally much like a spectrometer, are made of ¼-in. gas-pipe, and are not only convenient for attachments of objects of examination by ordinary clamps, but admit of a circulation of cold water, so that their lengths remain invariable for different air temperatures. The same apparatus may be adapted for observing the linear diffraction-reflection interferences described by M. Barus and the author [Abstract No. 1268 (1910)]. It is adapted for high-temperature investigation, adiabatic transformations, &c., and tubes of considerable length may be inserted in the interfering beams of light. The apparatus has been tested by some tentative measurements of the index of refraction of air at low temperatures, and the resulting relations between temperature and pressure are tabulated. For a tube 28·8 cm. long the micrometer displacement is about 0·000025 cm. per deg. C. The displacement of ellipses for a pressure of 1 atmo. is roughly from the D, nearly to the E line of the spectrum. In an alternative method of using the instrument the reading for the micrometer displacement need not be taken; the displacement of ellipses is accompanied by the radial movement of rings to and from the centre, and the number of rings vanishing may be counted. This ring method, though more sensitive, is less expeditious. For pressure measurement, however, the method has the rare advantage of being absolutely instantaneous in recording the state of the gas. A. E.

660. *Construction and Testing of a Quarter-wave Plate of Mica.* **L. Chaumont.** (Comptes Rendus, 154. pp. 271–274, Jan. 29, 1912.)—Chauvin's method (Journ. de Physique, Ser. 2. 9. p. 21, 1890) of analysing an elliptic vibration has been chiefly applied to very flattened vibrations, and in applying it to cases where the birefraction is considerable certain difficulties are encountered, owing to reflection at the faces of the plate traversed by the ray. These undesired reflections may be suppressed by immersing the mica plate in carbon disulphide, whose index is nearly the same as that of mica. The mica plate is set to form the bisecting plane of a prismatic vessel of angle 1/100, the faces of which are two pierced glass discs. After inserting the liquid carbon disulphide, each disc is covered by a plane-parallel plate made of unannealed flint glass, which is slightly birefringent. On passage of a ray the first reflected pencil now makes with the direct pencil an angle of 0·032, and can easily be stopped out by means of a diaphragm. Under these conditions, with the green light of the mercury arc, complete extinction can be obtained for the critical positions of the analyser, and the azimuth of the vibration can be determined to within about half a minute, even when the vibration to be analysed is nearly circular. It is not essential, in applying Chauvin's method, that the plate be exactly a quarter-wave one, but it is important to know for what wave-length it would be exact. The following is a rapid method of test:—Another mica, already tested in the ordinary way, is mounted in liquid as above, and used to produce elliptic light by placing it in the path of a bright pencil of white light plane polarised at 45° to the neutral lines. The mica plate to be examined is placed, unimmersed, in front, with one of its neutral lines parallel to the principal section of the polariser. On examining it with the analyser and spectroscope, a channelled spectrum is seen with sharp fringes whose minima are zero for two positions of the analyser. On rotating the analyser these fringes shift in one direction or the other, except the fringe corresponding to that radiation for which the plate is a true quarter-wave plate, which remains stationary, disappearing or appearing according to the orientation of the analyser. A. E.

661. *Fata-Morgana.* **F. A. Forel.** (Comptes Rendus, 153. pp. 1054–1056, Nov. 27, 1911.)—With reference to the mirage-like phenomena often observed in the Straits of Messina, it is thought to be due to the peculiar refractions produced about the time of transition between the two types of refraction of morning and afternoon, one where the air is cooler than the water, the other where the air is hotter than the water. With the eye at a convenient height both these types of refraction will be present somewhere in the line of sight, and the peculiar striated structures characteristic of the fata-morgana will result. C. P. B.

662. *Electric Double Refraction in Artificial Clouds.* **P. Zeeman** and **C. M. Hoogenboom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 786–788, Feb. 22, 1912.)—The experiments previously described [see Abstract No. 304 (1912)] were continued. It was found that contrary to the first conclusion, double refraction, as well as dichroism, is induced by electrostatic fields in a sal-ammoniac cloud. The cloud undergoes, in course of time, a remarkable change; the colour alters, and the induced double refraction is at first positive, afterwards negative. The dichroism does not change its direction. The observations show that at least two different modifications of sal-ammoniac clouds exist, which exhibit double refractions of opposite sign; at the same time the absorption of vibrations parallel to the field always exceeds that of vibrations at right angles to the field. One of the special intermediate states of the cloud, when under electric action, exhibits dichroism alone and no double refraction. J. J. S.

663. *Refraction and Magnetic Rotation of Mixtures.* **P. T. Muller** and **Mlle. V. Guerdjikoff.** (Comptes Rendus, 154. pp. 507–510, Feb. 19, 1912.) —While in general the curves relating refraction and rotation, respectively, to the concentration run parallel, with lithium chloride, ammonium nitrate, and mixtures of alcohol and aniline, it is found that the refractive index undergoes an abrupt increase while the rotation angle increases regularly. The effect only occurs above a certain concentration, which is higher for LiCl than for $AmNO_3$. L. H. W.

664. *Selective Reflection of Salts of Chromium and other Oxygen Acids.* **H. A. Clark.** (Astrophys. Journ. 35. pp. 48–74, Jan., 1912. Phœnix Physical Laborat. Contributions, No. 25.)—The work was undertaken to test conclusions of Pfund, Coblentz, and Morse, which are consistent with the assumption that a strong reflection maximum is a resonance effect, that the oxygen atom in the molecule is the resonator, and that the resonator is closely loaded with other oxygen atoms and with the acid-forming element in the molecule, but is loosely loaded with the base. Reflection curves for salts of the chromium acids were determined in the region $1{\cdot}5\,\mu$ to $15{\cdot}0\,\mu$. The short wave-lengths are omitted in the paper, because the reflection is constant in that region. One salt was a polished crystal, which should be examined further with polarised energy. Some surfaces were made from the powdered salt, pressed against a steel plate and polished, or pressed against glass to avoid polishing. Others, including those strongly hygroscopic, were pressed against rock-salt cover-plates, and the reflection measured through the cover-plates. This last method may prove valuable, but its errors require further investigation. The dichromates show two complex maxima, in the regions $11{\cdot}0\,\mu$ and $13{\cdot}5\,\mu$, respectively. The other salts show only each a single complex maximum; these maxima are in the region $11\,\mu$ to $12\,\mu$ for all but the chromites, in which they are from $15\,\mu$ to $16\,\mu$. In general, the salts of any one type have the same number of peaks in each complex maximum. One salt, K_2CrO_4, ought to prove a good source of *Reststrahlen*, with a mean wave-length of about 11·0 μ. When salts of one type only are compared with one another, all (except the chromites) show an approximately linear shift of the resonance region, towards the long waves, with increasing atomic weight in the base. This rule holds, not only for resonance regions as a whole, but, in most cases, for individual peaks in complex maxima. Representative shift lines suggest that each type of salt has its own characteristic rate of shift. A rate of shift enormously greater than the above-mentioned is shown for all the salts of any one base, when the shift is plotted against that fractional part of the weight of the characteristic element in the acid radical, which is united with three atoms of oxygen. It seems likely that the rate of shift of this latter sort is characteristic of salts of any one base. It is evident, however, in the case of the chromates and chromites concerned, that the shift due to replacing one Cr atom by two is much less than if the one atom were replaced by another of twice its atomic weight. The shifts of reflection maxima, as pointed out by Pfund, Coblentz, and Morse, are therefore confirmed for salts of the chromium acids, and further relations are pointed out. A. E.

665. *Optical Constants of Alloys as a Function of Composition.* **J. T. Littleton, Jr.** (Phys. Rev. 33. pp. 453–466, Dec., 1911.)—According to Drude's theory the electrical conductivity is a function of N the number of electrons per cm.^{3}, and *r* the friction coefficient, and for short waves the optical properties depend upon N and not upon *r*. By alloying two metals, however, and forming a new compound, N can be changed, and the study of the optical properties of these alloys should indicate such a change. In alloys of two metals which do not mix, but crystallise out separately, the conductivity of the alloy is related to those of the pure metals by a simple volume proportion. In alloys of two metals which are miscible in all proportions, the conductivity curve has a minimum. When the two metals are miscible in certain proportions and not in others the conductivity curve is partly curved and partly linear. The author's investigations show that the curve plotted for the relation between the optical constants and the percentage composition has the general form of the characteristic conductivity curve for each class of alloy. Two points of interest are brought out: (1) No increase in reflecting power over that of the pure metal is gained by alloying with a metal of lower reflecting power; (2) the optical constant curves are straight lines for the alloys of iron with Ni and with Mn and the alloys of Ni-Si; on the other hand, the optical constant curves depart very markedly from this linear form for the alloys of Cu with Fe, Ni, and Al. The "linear" class of alloys is formed of metals of low electrical conductivity, while the "non-linear" class always has as one constituent a metal of relatively high electrical conductivity—a fact leading to the assumption that the linear relation is due to the low electrical conductivity of the two component metals. The Lorentz law of refractivity deduced for dielectrics holds for high-resistance metals but not for low. A. E.

666. *Laws of diffused Reflection.* **V. Návrat.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1229–1246, July, 1911.)—Reflection from diffusing surfaces appears to be of a complicated character, and opposing conclusions have hitherto been drawn from researches on this point. Wright [Abstract No. 462 (1900)] finds that rays are not polarised by reflection from an absolutely matt surface, and that incident polarised rays are completely depolarised. On the other hand, Umow [Abstract No. 2178 (1905)] finds that matt surfaces do not com-

pletely depolarise incident light, that only an ideal white surface would do this, and that a truly dead black surface does not depolarise at all; also that in general those rays are most depolarised which resemble the natural colour of the material most closely. The explanation appears to lie in Arago's remark that the reflected rays which are responsible for the colour of a material emanate after penetrating some distance into its interior, and are therefore polarised as transmitted light would be. The author has therefore carried out some spectrophotometric and polarimetric investigations on the light reflected from various surfaces (dead black, smooth magnesia, white filter-paper, surfaces dyed with chrome-red and chrome-yellow, &c.). He presents the results in the form of a series of curves and draws the following conclusions: (1) When light polarised in the plane of incidence and observation falls on a matt surface only slight depolarisation (which becomes less with shorter wave-length) takes place, provided there is no reflection from within the material, but (2) considerable depolarisation takes place if the rays are polarised in a plane perpendicular to the plane of observation (increasing with shorter wave-length). (3) Ordinary light is polarised by reflection from a matt surface, the more so with shorter wave-lengths. (4) Reflection out of a deep layer exhibits the same dependence of polarisation on wave-length as in the case of surface-reflection, in so far as the intensity does not alter with the wave-length. (5) Coloured materials depolarise most strongly those rays which are most readily reflected from their interior, and *vice versâ*. (6) If a body possesses an optically fibrous structure the light reflected from its interior will be found to have a stronger component polarised in this plane than would be the case with a structureless body. Reflection is more frequently so influenced in the case of short wave-lengths than long ones. J. S. D.

667. *Note on the Iridescent Colours of Birds and Insects.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 85. pp. 598–605, Nov. 30, 1911.)—The author's experiments lead him to the conclusion that the colours are to be ascribed to interference rather than to selective reflection. L. H. W.

668. *Interference Points with a System of Right-angled Prisms.* **H. Schulz.** (Phys. Zeitschr. 12. pp. 1211–1213, Dec. 15, 1911.)—When a pair of right-angled prisms are placed with their hypotenuse surfaces nearly in contact, leaving only a thin film of air between, a peculiar system of coloured points is seen on looking in a direction normal to the film, near the extremities of the hypotenuse. The phenomenon is explained by the crossing of two sets of interference bands. Both sets of bands are due to the splitting-up of rays by the thin film of air, but in one case the rays undergo reflection at the three interior faces of the upper prism before entering the film of air to form the bands; in the other case the rays undergo reflection at the three faces of the lower prism after the bands are formed by the film. In the first case the interference bands are seen direct, in the second they are seen reversed, and the two sets of bands appear crossed. The phenomenon may be rendered more conspicuous and extended over a wider region by silvering one side face of each prism. The higher the reflection coefficient of the hypotenuse, the more favourable the distribution of intensity for observation of the phenomenon. Under certain conditions, by suitably silvering the hypotenuse surface, both sets of bands may be seen double, resembling the appearance with polarised light. A later paper will deal with the resolving power of this prism-system, and the possibility of utilising it to distinguish very small differences of wave-length. A. E.

669. *Testing Lenses for Three-colour and Process Work.* **A. J. Newton** and **A. J. Bull.** (Photographic Journ. 52. pp. 91–94; Discussion, pp. 94–98, March, 1912.)—The aberrations that impair the definition of a lens are usually classed as (1) axial spherical aberration, (2) coma, (3) radial astigmatism, (4) curvature of field, (5) distortion. In addition, there are chromatic variations of which the ordinary chromatic aberration of position of the image plane and the chromatic variation of magnification are the most important. These aberrations are usually considered from the point of view of the ordinary user, and tests are applied accordingly. Reasons are given why the photographic method of testing is to be preferred to the visual, and the camera is described which is adapted for this class of work. No attempt is made to separate the various aberration effects, only the general definition being considered. During the *discussion,* **C. P. Butler** and **Chapman Jones** adversely criticised the collimator employed, otherwise the apparatus is considered useful. A. E. G.

670. *Telephotography.* **O. Wheeler.** (Photographic Journ. 52. pp. 62–68; Discussion, pp. 68–71, Feb., 1912.)—A brief discussion of the usual formulæ employed in telephotography is given. It is suggested that advance in this branch of photographic work is to be expected in the following directions: (1) high magnification, (2) special screens for long-distance work, (3) instantaneous telephotography especially with reference to aerial reconnaisance, (4) panoramic telephotography, (5) colour work. The use of compound tel-negatives is also discussed. During the discussion the relative merits of the hood and of a dead-black lining to the lens tube received much attention. A. E. G.

671. *Photo-chemical and Photo-electric Phenomena.* **G. Reboul.** (Comptes Rendus, 154. pp. 424–426, Feb. 12, 1912.)—The emission of negatively-charged particles under the influence of ultra-violet light presents the following peculiarities when the insulated surfaces are sensitive to photo-chemical action. In general, the Hertz-Hallwachs phenomenon shows fatigue by a diminution in the intensity of the charges emitted, but when the insulated surface is sensitive to the action of light, an increase in the intensity takes place with prolonged action of ultra-violet light; polished Cu and Cu coated with copper bromides are examples of this. The increase of the effect is followed, after a sufficient exposure interval, by fatigue. This fatigue may occur in the dark, but is more rapid under the action of light: in the latter case it is so much the more rapid the more advanced the blackening of the salt. When the salt has been exposed to light until its decomposition is complete, the escape of negative charges practically ceases. The fatigue acquired under the action of light may be partly removed by placing the salt in darkness. With the halogens of copper the photo-chemical sensitivity depends upon the thickness of the layer of salt, and it is now found that the thicker the sensitive layer the more intense is the emission, and the greater the increase with the duration of insulation. The intensity of emission with the metal is in general smaller than with metal covered with a layer of sensitive salt of sufficient thickness and after a suitable exposure. A. E. G.

672. *Photometric Paddle-wheels.* **J. R. Milne.** (Roy. Soc. Edinburgh, Proc. 31. pp. 656–683, 1910–1911.)—The ordinary form of rotating sector used in photometry is open to the objection that it is difficult to adjust the amount of light passing, and to record this adjustment while the sector is in motion; even when this is accomplished, the accuracy in displacing parts of

a body moving at a high velocity must be strictly limited. The author has therefore contrived "paddle-wheels" which are interposed in the beam of light and have the advantage of being made in one entire piece. These paddle-wheels are rotated about a horizontal axis, and they can also be displaced about a vertical axis, thus varying progressively the degree of obstruction to the light. The shape given to the wheels will depend upon the range of alteration required and other circumstances. The author works out the formula to be applied for several convenient shapes, and presents this for use in the form of a graph. In conclusion, he describes some details in the arrangement and mounting of the apparatus, including a mechanism enabling readings to be automatically recorded. J. S. D.

673. *Factors in Heterochromatic Photometry.* **L. Bell.** (Electrical World, 59. pp. 201–203, Jan. 27, 1912.)—It is generally agreed that the Purkinje-effect is mainly noticeable at low illumination. For instance, Dow has found [see Abstract No. 1560 (1906)] that the true effect was insignificant with a Lummer-Brodhun photometer, and using red and green shaded glow-lamps, at illuminations over 0·025 candle-ft.; and this figure is confirmed by other experiments. Nevertheless, colour discrepancies are recorded at higher illumination with larger illuminated areas by some people. The author suggests that this is caused mainly by an accentuation of the Purkinje-effect owing to simultaneous contrast of the adjacent heterochromatic fields. This effect is present in a photometer of the "equality of brightness" pattern, but not so in the case of the flicker photometer, and experiments have shown that the latter is less subject to the Purkinje-effect. The author is therefore disposed to consider this type of photometer advantageous for observing sources of light which differ greatly in colour. J. S. D.

674. *Modern Problems in Illumination.* **T. T. Baker.** (Soc. Arts, Journ. 60. pp. 448–458; Discussion, pp. 458–461, March 8, 1912.)—The paper is mainly concerned with physical and physiological effects of coloured light. It appears that ultra-violet, violet, and orange rays affect bacteria, but that the intermediate yellow-green region has little effect. The author also refers to the artificial simulation of daylight, suggesting that a screen for use with tungsten lamps might achieve this with a loss in absorption of only 2 to 3 per cent. Reference is next made to the use of photographic methods in estimating brightness throughout the spectrum. Spectrophotographs of various arcs are shown and some remarks made on the quality of spectra yielded by luminescent helium, neon, and nitrogen, as exemplified in the Moore and Claude tubes. In the *discussion*, **A. P. Trotter** and **L. Gaster** doubted if daylight imitation from the tungsten lamp with only 2 to 3 per cent. absorption was possible. Such a screen had actually been shown by K. Mees, and the absorption was nearer 85 per cent. **F. W. Edridge-Green** pointed out that kinds of yellow light obtained by mixing bands of spectrum colours in varying proportions were not physiologically identical even although they might appear to the eye to match. **T. E. Ritchie** thought that the arc spectra shown could not have been obtained with pure carbons. **J. S. Dow** suggested that visual tests should always be used to supplement photographic tests of luminosity. J. S. D.

675. *Ponderomotive Effects of Circularly-polarised Rays.* **S. Pokrowsky.** (Phys. Zeitschr. 13. pp. 158–161, Feb. 15, 1912.)—Points out that a system receiving a circularly-polarised ray should experience there a torque corre-

sponding in direction with that of the circular polarisation. Also the system emitting such a ray must experience an equal but opposite torque. [See Abstract No. 881 (1912).] E. H. B.

676. *Spectrum of Cyanogen.* **A. Fowler** and **H. Shaw.** (Roy. Soc., Proc. Ser. A. 86. pp. 118–130, Jan. 31, 1912.)—In connection with Strutt's investigations of the interaction between the active modification of nitrogen and certain compounds of carbon [see Abstract No. 1210 (1911)], it became necessary to compare the resulting spectra with the spectrum given by cyanogen under the more usual conditions of experiment. Various methods were employed for obtaining the cyanogen spectrum, and a new series of measurements of the bands in the less refrangible parts of the spectrum was undertaken, a spectrograph of the Littrow type being used. Revised wave-lengths are given for these bands, numerous bands not previously recorded being included. The heads of the bands can be arranged in regular series similar to those constituting the first positive band-spectrum of nitrogen. There are considerable variations in the relative intensities of the various bands, according as the spectrum is obtained from the flame of the burning gas, from a vacuum tube or from the luminous glow produced by the interaction of certain compounds of carbon with active nitrogen. A comparison of the complex spectrum of the arc between carbon poles with the spectrum of cyanogen indicates that the red and yellow portions of the carbon arc spectrum are almost entirely due to cyanogen. The photographs reproduced show that not only are the brightest places in the arc spectrum coincident with the heads of the cyanogen bands, but that the structure lines are, for the most part, the same in both cases. The correspondence between the two spectra, however, is not complete when the cyanogen spectrum is obtained from a vacuum tube. It appears probable that the greater similarity between arc and flame, than between arc and vacuum-tube spectra is to be attributed to the nearer equality of pressure conditions, as some band spectra are known to vary with pressure. The spectrum of cyanogen in the sun is not of sufficient intensity to give visible indications of the red and yellow bands. Adequate data for comets and stars of Secchi's fourth type are not available for comparison. A. W.

677. *Spectroscopic Investigations in Connection with the Active Modification of Nitrogen.* II. *Spectra of Elements and Compounds excited by the Nitrogen Afterglow.* **R. J. Strutt** and **A. Fowler.** (Roy. Soc., Proc. Ser. A. 86. pp. 105–117, Jan. 31, 1912.)—Preliminary investigations of spectra are made by direct observation with a small quartz spectrograph; when greater resolving power is required a larger quartz spectrograph and an instrument of the Littrow type are used. The arrangements for obtaining the afterglow have been described in papers, of which the present is a continuation [see Abstracts Nos. 1210, 1889 (1911), and 596 (1912)]. By means of a mechanical pump a stream of purified nitrogen at low pressure is passed through the discharge tube, and the afterglow is observed in a side tube into which various substances are introduced as required. The spectra of the following substances are investigated: Metallic elements—Na, K, Mg, Hg, Tl, and Ni: halogens—iodine, bromine, and chlorine: compounds of metals—cuprous chloride, chlorides of tin, and mercuric iodide: sulphur and its compounds—sulphur, sulphuretted hydrogen, and carbon disulphide: carbon compounds. The following are the general results obtained. (1) The spectra generated by the nitrogen afterglow do not differ fundamentally from those which can

be produced by other means of excitation. In many cases, however, band spectra are better displayed in the afterglow, and the more refrangible parts of the spectrum are more completely developed. The method, therefore, adds to our resources for the production of spectra. (2) The spectra of metallic substances approximate to those obtained in the electric arc, or are intermediate between arc and flame spectra. In the case of Na when sufficiently heated, the max. intensity in the principal series is at λ3303, the D lines being nearly extinguished. (3) The spectra given by iodine, chloride of tin, and mercuric iodide are very similar to those obtained from vacuum tubes. There is, however, a greater development of the more refrangible parts of the spectrum in the case of the glow. (4) The band spectrum of cuprous chloride is more completely developed in the glow than in the Bunsen flame; it shows an additional series of bands in the ultra-violet, which is probably related to the series which constitute the flame spectrum. (5) The spectra exhibited by sulphur, SH_2, and CS_2 consist of bands which are quite distinct from those given by sulphur in a vacuum tube, but resemble the bands of the CS_2 flame in air. (6) The cyanogen spectrum which is developed in the glow by cyanogen and certain other compounds of carbon differs in several respects from that observed in the cyanogen flame or carbon arc. Some of the differences appear to be due to the production of the spectrum at a relatively low pressure in the glow. A new set of bands, occupying positions near the more refrangible edges of the violet groups, occurs in the glow spectrum and has also been observed during the phosphorescent combustion of cyanogen in oxygen. A. E. G.

678. *Vacuum-tube Spectra of Vapours of Metals and Metallic Chlorides.* I. **J. H. Pollok.** (Roy. Dublin Soc., Proc. 13. 15. pp. 202–218, Feb., 1912.)—The scope of the present paper is confined to a rapid survey of a large number of metals and their chlorides, and the identification of the lines that are common to both spectra, with some indication of the relative intensities of the lines in the spark spectrum and in the vacuum-tube spectra with and without a condenser, together with the approximate position of the bands that are a prominent feature of some of the vacuum-tube spectra. A special quartz tube was used, a Mecker burner being employed to vaporise the substance under investigation. The materials dealt with were Cd, Zn, Tl, Hg, Sn, Bi, Cu, As, Sb, and Al and their chlorides. Tables are given of the principal lines, with notes on the principal characteristics of the spectrum in each case. The general conclusions to be drawn from a study of the spectra so far examined are: (1) That the lines shown by the vacuum-tube spectra of metallic vapours consist of all, or some, of the lines shown by the metallic spark spectrum of the same element. (2) That those lines which show as continuous lines in the spark spectrum of an element are invariably the strong lines of the vacuum-tube spectrum, and discontinuous spark lines often do not show, particularly when no Leyden jar is used. (3) That certain lines are enhanced by the introduction of a Leyden jar, and that such lines are very frequently prominent discontinuous lines in the spark spectrum of the metal. (4) That some lines show more prominently without a Leyden jar than with it; but this is a rather exceptional phenomenon. (5) That with the chlorides precisely the same lines are obtained as with the vapour of the metal, with or without the addition of the lines of Cl, according to circumstances. (6) That the Cl lines, as a rule, do not show unless a Leyden jar is used, and even then they do not show with equal facility with all compounds. (7) That in all cases where a line is enhanced or otherwise by the

introduction of a condenser in the circuit with the vapour of the metal a precisely similar change takes place with the chloride. (8) Lines that show in the arc spectrum of an element, but not in the spark spectrum, are not seen in the vacuum-tube spectra of the element, either with or without a condenser. (9) That in many of the spectra, especially when much vapour is present, and no Leyden jar used, very beautiful bands develop, some of which are entirely new, and will require further study. They are quite independent of the lines of the spark spectra of the elements, and probably owe their origin to the molecules of the compounds under observation. A. W.

679. *Asymmetry of Zeeman Triplets.* **M. Risco.** (Anales de la sociedad española de fisica y quimica, 9. pp. 262–271, 1911. Phys. Zeitschr. 13. pp. 137–142, Feb. 15, 1912.)—A Fabry and Perot étalon was used to investigate the Zeeman-effect for the yellow mercury lines λ5791 and λ5770, and the central triplet of the λ5461 line. Particular care was taken with the measurements of the field intensity, and with the determination of the displacement of the central line. In the case of the line λ5791, it was found that the displacement $\Delta\lambda_0$ of the central line was given by $\Delta\lambda_0 = 0{\cdot}42 \times 10^{-12} H^2$, H being the field intensity. A calculation of *e/m* from the formula $e/m = 4\pi V \sqrt{(\delta\lambda_1 . \delta\lambda_2)}/H\lambda^2$ gave the value $+ 1{\cdot}868 \times 10^7$; $\delta\lambda_1$ and $\delta\lambda_2$ are the wave-length differences between the mean and the two outer components of an asymmetric triplet, and V is the velocity of light in the ether. Neither the line λ5770 nor the central triplet of the λ5461 line gave any asymmetry at all, but the mean component of the latter shows a certain tendency to be displaced towards the red. [See also Abstracts Nos. 784 (1908) and 849 (1909).] A. W.

680. *Influence of Fluorescence on Ionisation by Collision.* **J. Franck** and **W. Westphal.** (Deutsch. Phys. Gesell., Verh. 14. 3. pp. 159–166, Feb. 15, 1912.)—An alteration in the conductivity of fluorescent fluids is brought about by the action of light, and Stark and Steubing have also found in the case of some fluorescent gases and vapours a connection between photo-effect and fluorescence. On the other hand, Matthies has shown that a photo-effect is not always to be obtained with fluorescent gases; thus in benzol and iodine vapour it does not occur. It is now shown that the current in the glow discharge in iodine vapour is increased by illuminating the path of the discharge with light of a nature to produce fluorescence. The effect, however, has its origin in the gas itself, and is not dependent on the usual photo-effect, thus confirming Matthies' results so far as iodine vapour is concerned. The hypothesis is advanced that under the action of the light it is easier for the oscillating electrons to escape than under ordinary conditions. A. E. G.

681. *Fluorescence of Anthracene.* **L. S. Stevenson.** (Journ. Phys. Chem. 15. pp. 845–865, Dec., 1911.)—After a consideration of the various chemical and physical theories which have been proposed to account for the phenomenon of fluorescence, the author puts forward the following considerations. Fluorescence may take place if any of the following conditions are fulfilled: (1) A reaction, which is giving off light in the invisible spectrum, or which is giving off light of small intensity in the visible spectrum, is taking place all the time. The incident light then either causes sufficient change of wave-length to bring the emitted light into the visible spectrum, or else accelerates the reaction sufficiently so that visible light is given off. (2) In the presence of light there is a change from one form to a second tautomeric

form. Light is given out during the formation of the second substance, or during the re-formation of the first, or during both. (3) The light causes a dissociation. Either in the dissociation or in the reassociation of the parts of the molecule light is evolved. This dissociation may be ionic or non-ionic in character. The author finds that (3) accounts for all known fluorescent anthracene derivatives and finds support in the evolution of light which takes place when chlorine acts upon anthracene in the formation of dichloroanthracene. (1) was found to be negatived by experiments in which a sensitive photographic plate (Σ Lumière plate) was exposed to solutions of certain fluorescent substances in the dark; no effect was produced. (2) is not in accordance with the fluorescence of anthracene and its derivatives, such as dihydroanthracene. T. S. P.

682. *Variation with Distance of Ionisation produced by Röntgen Rays.* **E. W. B. Gill.** (Phil. Mag. 23. pp. 114–121, Jan., 1912.)—In the experiments described the ionisation was measured at distances of 25 and 100 cm. from the anode of an X-ray bulb, and it was found that the number of ions produced is proportional to the inverse square of the distance. The experimental arrangement was such that the absorption of the X-rays was the same in both cases, by using an intervening vessel which could be evacuated. With a hard bulb, however, it was found that the absorption by 76 cm. of air at atmospheric pressure was negligible. The result is discussed in the light of the corpuscular and pulse theories of X-rays, and compared with that of Griffith [Abstract No. 1678 (1907)] on ionisation by ultra-violet light. It is concluded that if the forces in a Röntgen-ray pulse are in any way comparable to those in a beam of ultra-violet light, the results of this experiment discredit to some extent the pulse theory; while establishing, as they appear to do, the uniformity of ionisation per cm. in a beam of rays, they remove a possible objection to the corpuscular theory. E. M.

683. *Dependence of Penetrating Power of Röntgen Rays upon the Pressure and Nature of the Gas.* **C. L.** and **F. A. Lindemann.** (Phys. Zeitschr. 13. pp. 104–106, Feb. 1, 1912.)—These experiments were carried out with a constant current (1·5 milliamps.), the hardness of the tube being varied as required. Results obtained with air, hydrogen, oxygen, chlorine, CO_2, argon, and helium are given in both tabular and graphical form. These show that the hardness increases in every case as the pressure is lowered, the increase being more marked at the lower pressures. A. E. G.

684. *Homogeneous Fluorescent X-radiations of a Second Series.* **C. G. Barkla** and **J. Nicol.** (Phys. Soc., Proc. 24. pp. 9–17; Discussion, p. 17, Dec. 15, 1911.)—It has been shown that the fluorescent X-radiations emitted by elements exposed to primary Röntgen radiation can be arranged in series, one radiation in a particular series being emitted by each element, and the radiation belonging to that series becoming more penetrating with an increase in the atomic weight of the radiating element. [See Abstracts Nos. 81 (1910), 1498 (1911).] The homogeneity of radiations of only one series (the K series) was shown by Barkla and Sadler. The present paper describes experiments showing the homogeneity of fluorescent X-radiations in the second series (the L series), and exhibiting the homogeneity of radiations of the two series from a number of elements. Details are given of the observations on the radiations from barium, and similar results are recorded in the case of the radiations from iodine, Sb, and Ag. The homogeneous fluorescent radiations of different

series are emitted simultaneously by an element exposed to Röntgen radiation of more penetrating type than either. The fluorescent X-radiations can thus be analysed into well-defined radiations widely different in penetrating power, and may be said to give a line spectrum in X-rays. The absorbability of the fluorescent radiations is given by the following values of λ/ρ, where λ is the coefficient of absorption of these radiations in Al of density ρ.

Ag radiator	(Series K)	[2·5]	(Series L)	700
Sb "	"	1·21	"	435
I "	"	0·92	"	300
Ba "	"	0·8	"	224

E. M.

685. *Scattered Röntgen Radiation from different Radiators.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 16. Part 4. pp. 365–369, Dec. 1, 1911.)—It has been generally assumed that the amount of scattered Röntgen radiation from a given mass of a radiator is practically independent of the chemical nature of a radiator. The assumption rests mainly on experiments made on elements of low atomic weight [Abstract No. 61 (1908)] for which the characteristic secondary radiation is either not excited or is too small to be appreciable. The present paper deals with heavier metals, the scattered radiations from paper, Al, Ni, Cu, and Sn being compared at various angles on the incident and emergent side. The first two substances are not known to emit any homogeneous radiations; the radiations from Ni and Cu are very soft and easily absorbed, while the characteristic radiation from Sn is very hard and is not excited by a soft bulb. In all the experiments the distribution characteristic of the scattered radiation was found. The results show that the scattering per unit mass is not constant but is four times as much for tin as for paper. Combined with previous experiments this result appears to show that the scattered radiation per unit mass is a minimum for elements in the neighbourhood of carbon and oxygen and increases for both smaller and higher atomic weights. Various results were also obtained on the ratio of the scattered radiations at different angles with different thicknesses of material.

E. M.

686. *a-Particles emitted by Active Deposits of Thorium and Actinium.* **E. Marsden** and **T. Barratt.** (Phys. Soc., Proc. 24. pp. 50–61, Dec. 15, 1911.)—This paper is divided into three sections: (1) Discussion of the probability laws as applied to the emission of α-particles. (2) Experiments with actinium active deposit. (3) Experiments with thorium active deposit. The double screen method of counting scintillations is employed. No irregularities in the emission of α-particles from the active deposit of Ac are shown in the experiments, and it is therefore concluded that the 10 per cent. of connected particles found in the experiments of Geiger and Marsden are due to probability, and that no certain evidence of the existence of a short-life product can be drawn from them. The range of ThC_1 is found to be 4·8 cm. It is shown that there is a lateral disintegration in the active deposit of Th, ThC_1, and ThC_2 being on different branches. ThC_2 gives 1·88 times as many α-particles as ThC_1.

A. E. G.

687. *β-Rays of Radium D.* **J. Danysz** and **J. Götz.** (Le Radium, 9. p. 6, Jan., 1912.)—The authors have made observations of the magnetic spectrum of Ra (D + E + F). A thin-walled α-ray tube [Abstract No. 325 (1912)] was used which had previously contained RaEm that had been allowed to decay and produce the RaD. The results showed two fairly wide bands with maxima at speeds 0·968 and 0·944 of the velocity of light. The largest velocity represented by the swiftest band appeared to be about 0·995. There also appeared to be two maxima at speeds 0·87 and 0·48 of the velocity of light. The results of Gray and Wilson [Abstract No. 240 (1911)], that exponential absorption by matter is no criterion of homogeneity of velocity of β-rays, are thus confirmed. E. M.

688. *Direct Measurement of the Absorption of the γ-Rays from Radium C in Air.* **V. F. Hess.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1205–1212, July, 1911. Communication from the Inst. f. Radiumforschung.)—Workers on atmospheric ionisation are agreed that the major part of the penetrating radiation present at the surface of the earth comes from the earth itself. Not more than 3 per cent. or 4 per cent. appears to come from radio-active products in the atmosphere. This being so, the effect of the penetrating radiation should fall off rapidly with increase in altitude. Experiments show, however, that the diminution with altitude is much less than the amount demanded by theory. This suggests that the absorption of γ-rays by air is much smaller than is to be expected by calculation from a density law. The absorption of γ-rays of Ra in air has therefore been measured. The saturation current in a large receiver due to over 1 gm. of radium chloride was measured at distances of from 10 to 90 m. The inverse square law connecting intensity and distance was assumed to hold, and departures from it were ascribed to absorption by air. The mean value of μ found was $4{\cdot}47 \times 10^{-5}$ (cm.)$^{-1}$. At a height of 500 m., therefore, the ionisation due to γ-rays from RaC should be only a few per cent. of that at the surface. This is, however, contrary to experimental facts. E. M.

689. *Delta Rays.* II. **N. Campbell.** (Phil. Mag. 23. pp. 46–64, Jan., 1912.)—The paper contains an account of experiments in continuation of those described in a previous paper [Abstract No. 1502 (1911)], some of the former conclusions not having been verified. It is concluded that experiments on the relation between the current and p.d. between the electrodes can give very little information as to the speed of the δ-rays emitted from the electrodes. It appears that a great part of the change in the current due to a change in the field is due to the dragging-out from the electrodes of the δ-rays generated in them which were previously unable to escape. A minimum estimate of the speed of the δ-rays, deduced from the shape of the current-potential curve in the above experiments gives a value about that corresponding to a p.d. of 8 volts. It is shown that there is a considerable amount of evidence that the speed of the rays is independent of the speed of the α-rays by which they are excited, while it appears that the speed is also independent of the material from which the rays are emitted. E. M.

690. *Rate of Evolution of Heat by Orangite.* **H. H. Poole.** (Phil. Mag. 23. pp. 183–192, Jan., 1912.)—Orangite (a thorium mineral) was placed in a copper vessel inside two Dewar flasks and surrounded by ice. The heat evolution was measured by the difference in temperature between the orangite and the ice, using a thermocouple and standardising by a heating coil. The results of two sets of measurements at a year's interval were $25{\cdot}4 \times 10^{-6}$ and $19{\cdot}4 \times 10^{-6}$ cal. per hour per gm. The orangite was from Arendal, Norway, and contained 86 per cent. of Th. The decrease with time of the heating effect may be due to some molecular or chemical change occurring in the mineral due to previous treatment. The values are very

much greater than the calculated ones from the Th-content, while Pegram and Webb [Abstract No. 1436 (1908)] obtained a value for ThO₂ much more nearly in accord with radio-active theory. E. M.

691. *Ionisation produced by Recoil Radio-active Atoms.* **L. Wertenstein.** (Le Radium, 9. pp. 6–19, Jan., 1912.)—The paper contains a more detailed account of the experiments described in Abstracts Nos. 1601 (1910), 1852 (1911). It is shown that RaC emits, besides the α-, β-, and γ-rays, an ionising radiation consisting of (1) delta-rays, and (2) recoil atoms of RaD. The recoil atoms have a range in air of about 1/7 mm. at atmospheric pressure, and can with suitable plates contribute about 5 times as much ionisation over that range as the α-particles. Their range in hydrogen is about 7·5 times that in air. The range is also larger than that of the recoil atoms of RaB projected from RaA, owing to the greater speed of the α-particles causing them. The total number of ions produced by a recoil RaD atom appears to be about 1/250 of the number produced by an α-particle of RaC. E. M.

692. *Detection of Actinium in Minerals.* **G. v. Hevesy.** (Phys. Zeitschr. 12. pp. 1213–1214, Dec. 15, 1911.)—It was observed by Boltwood that although powdered uranium minerals gave off actinium emanation freely, yet when a stream of air was passed through the solution of the mineral very little emanation was apparently extracted [Abstract No. 1100 (1908)]. The author has investigated this question and finds that with suitable precautions more emanations is given off from the solution than from the powdered mineral. It is necessary that the washbottle containing the mineral solution should be quite full of liquid, as otherwise the air carrying the emanation circulates in eddies above the surface of the liquid, and the actinium emanation being of short life (period 3·9 sec.) becomes completely disintegrated before entering the measuring electroscope. E. M.

693. *Radium and Mesothorium in Monazite Sand.* **L. Haitinger, K. Peters,** and **S. Meyer.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1199–1204, July, 1911. Communication from the Inst. f. Radiumforschung.)—A preparation of radium extracted in 1904 from monazite sand has been examined in the light of recent researches to find if mesothorium also is present, and it was found that the preparation consists chiefly of mesothorium with only a very small quantity of radium. The authors find that the mesothorium is similar to barium in its chemical properties, separation, however, being effected by fractionation of the chlorides. It cannot be separated from radium. [See also Abstract No. 481 (1911).] A simple method of separating radiothorium from mesothorium is given. It was found that the bromides of radium and mesothorium are very soluble in water and can be separated from the insoluble radiothorium by decantation. E. M.

694. *Schweidler's Fluctuations.* **E. Meyer,** with Appendix by **N. Campbell.** (Phys. Zeitschr. 13. pp. 73–83, Jan. 15, 1912.)—The paper is somewhat polemical, and is a reply to some criticisms by Campbell on a previous paper [Abstract No. 81 (1911)] in which Meyer had deduced, from observations of fluctuations in the ionisation produced by γ-rays, that their energy is not uniformly distributed in an expanding sphere, but is concentrated in patches moving in certain directions. The author justifies his results both in the experimental accuracy and in the interpretation put on them. Campbell replies. E. M.

695. *Fluctuations in Radio-active Radiations.* **K. W. F. Kohlrausch** and **E. v. Schweidler.** (Phys. Zeitschr. 13. pp. 11–14, Jan. 1, 1912.)—Hitherto observations of v. Schweidler's fluctuations have been made by balancing ionisation effects in some way and observing only the departures of the value of the current from zero [Abstracts Nos. 626, 926 (1908)]. The authors have succeeded in detecting fluctuations in the ionisation produced by the α-particles from polonium with a sensitive electrometer by simply measuring its rate of charge. Also the ionisation effect of a single α-particle was detected by observing the motion of the needle of the electrometer. The present paper is a preliminary publication. E. M.

696. *Relations between the Properties of Radio-active Elements.* **R. Swinne.** (Phys. Zeitschr. 13. pp. 14–21, Jan. 1, 1912.)—Between the value of the disintegration constant λ of an α-ray product and the initial velocity of expulsion of the α-particle, v_a, the author shows that there exists the relation: $\log \lambda = a + bv_a^n$ for any of the radio-active series, where a, b are constants and $n = 1$ or 2, the former value giving better agreement than the latter [see Geiger and Nuttall, Abstract No. 613 (1912)]. The differences between the values of v_a for any two of the products RaEm, RaA, and RaF are shown to be the same as the corresponding differences for AcEm, AcA, and AcC, or ThEm, ThA, and ThC. Analogous relations hold for other radio-active elements. The author also shows that a similar empirical relation exists in the case of β-rays products. E. M.

697. *Effect of Temperature on Radio-active Disintegration.* **A. S. Russell.** (Roy. Soc., Proc. Ser. A. 86. pp. 240–253, Feb. 28, 1912.)—The effect of temperature upon the rate of decay and the amount of β- and γ-ray activity of RaEm, of active deposit, and of RaC has been investigated. The results are entirely negative. All abnormalities of activity of β-rays obtained by previous authors, and by the author in this research, may be completely explained on two simple grounds. The first of these is a change of distribution of RaC caused by its partial volatilisation inside the quartz tube at temperatures higher than 320° C. The second is a change of partition of RaC between the walls of the quartz envelope and the space enclosed. At room temperature the greater part of the RaC is usually on the walls. At room temperature, after the tube has been cooled suddenly from high temperatures, it is *entirely* on the walls. Above 650° C. the RaC is distributed homogeneously throughout the volume of the tube. Each of these partitions gives a different β-ray ionisation in the electroscope, because the average path of the rays through the walls of the quartz envelope depends on the partition. Under the conditions of experiment, RaB and RaC, and very probably RaA, may be completely volatilised inside sealed quartz tubes at a temperature of 650°. RaB commences to volatilise at room temperature. E. M.

698. *Scattering of α-Particles.* **H. Geiger.** (Roy. Soc., Proc. Ser. A. 86. pp. 235–240, Feb. 28, 1912.)—In a previous paper [Abstract No. 1248 (1910)] experiments were described on the scattering of α-particles by foils of various materials and thicknesses. The present note deals with a theoretical examination of the question. The type of scattering considered has recently been termed by Rutherford "compound scattering" [Abstract No. 1347 (1911)] in order to distinguish it from another type, denoted as "single scattering" which concerns the deflections through large angles, in an α-particle in a single atomic collision. The "compound scattering" is considered as the

result of a multitude of small deflections of the α-particle by the individual atoms of the matter traversed. The experimental curve of distribution with angle for a scattered pencil of α-particles is found to be in good agreement with that derived from simple probability theory. The deductions also explain the experimental result that for thin foils, which do not appreciably alter the velocity of the α-particles, the most probable angle of scattering varies as the square root of the thickness. To find the variation of the most probable scattering angle for large thicknesses of matter traversed, the change in velocity of the α-particles has to be taken into account. Assuming, as found by experiment, that the most probable angle of scattering is inversely proportional to the third power of the speed, the theoretical curve is found to give a satisfactory explanation of the experimental results obtained with thick foils. E. M.

699. *Ranges of α-Particles from Uranium.* **[Miss] F. Friedmann.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1361–1371, Oct., 1911.)—From the shape of the absorption curve by aluminium of the ionisation from a thin film of U_3O_8 under various experimental conditions it is deduced that Ur emits two sets of α-particles whose ranges are calculated to be 1·6 cm. and 2·7 cm. respectively. E. M.

700. *Question as to Existence of a Radio-active Product between Uranium and Uranium X.* **H. Sirk.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1569–1574, Nov., 1911.)—The author has repeated the work of J. Danne, who announced in 1909 the discovery of a radio-active product, radio-uranium, intermediate between the Ur and UrX [Abstract No. 473 (1909)]. He has also made other experiments in an attempt to isolate this body, but altogether without success. Repetition of Danne's work did not lead to the results given by him. E. M.

701. *Measurement of the Earth's Penetrating Radiation on a Balloon.* **V. F. Hess.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1575–1585, Nov., 1911.)—According to present knowledge the radio-active bodies in the earth are the source of the penetrating γ-radiation observed by many experimenters. The effect due to radio-active products present in the atmosphere is negligible. It is hence to be expected that the intensity of this radiation should fall off with altitude owing to its absorption by the atmosphere. The author has therefore made measurements on two balloon journeys up to a height of 1070 m. Practically no diminution of ionisation was observed in the electroscope with increasing altitude. The author concludes that in addition to the γ-rays there must be another source of penetrating ionising radiation in nature. E. M.

702. *Influence of β-Rays on the Growth of Seeds.* **E. D. Congdon.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1327–1336, Oct., 1911.)—The results show that β-rays from 8 mgm. of Ra have a considerable retarding influence on the growth of the seeds tried [*Panicum germanicum, Sinapis nigra, Amaranthus monstrosus, Nicotiana Tabacum*, and *Papaver somniferum*]. The amount of retardation depends on the position of the germ and nature of the seed in general. The results are discussed from the point of view of the chemical constitution of the seeds. E. M.

703. *Radio-activity of Mineral Springs in Taiwan (Formosa, Japan).* **D. Isitani** and **I. Yamakawa.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 12. pp. 178–194, Jan., 1912.)—The authors have investigated the radium emanation given off from the waters and gases of a large number of hot

springs. For the measurements a cylindrical ionisation chamber was employed and the amount of emanation was deduced from the dimensions and saturation current, using the formula given by Duane and Laborde [Abstract No. 926 (1910)]. The amounts of emanation obtained per litre varied from $2{\cdot}4 \times 10^{-12}$ to 287×10^{-12} curies, while for the naturally-evolved gases of the springs amounts of emanations varying from 50 to 2500 curies per litre were obtained. The waters were found to have a very small Ra-content—probably far too small a quantity to be the parent of the emanation found. E. M.

704. *Report on Radio-active Waters of Bath.* **W. Ramsay.** (Chem. News, 105. pp. 133–135, March 22, 1912.)—The paper deals mainly with the radium-content of, and the niton (radium emanation) given off from the various waters. It was found that the water from King's Well contains 1·78 mgm. Ra per million litres. A further special feature of the analysis was the very large quantity of Ne and He present in the evolved gases, relative to the percentage in the atmosphere. E. M.

705. *New Speculum Condenser.* **J. W. Gordon.** (Photographic Journ. 52. pp. 72–78; Discussion, pp. 78–79, Feb., 1912.)

706. *Spectrophotometer with Colour-mixing Apparatus.* **H. Kruess.** (Zeitschr. Instrumentenk. 32. pp. 6–13, Jan., 1912.)

707. *Propagation of Waves through a Stratified Medium, with Special Reference to Reflection.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 86. pp. 207–226, Feb. 28, 1912.)—Mathematical.

708. *The Photographic Industry.* **C. E. K. Mees.** (Soc. Chem. Ind., Journ. 31. pp. 307–310; Discussion, pp. 310–312, April 15, 1912.)—Deals with factory organisation in the preparation of dry plates, and with testing methods.

709. *Colour-blindness and Trichromatic Theory of Colour Vision.* II. *Incomplete Colour-blindness.* **W. de W. Abney.** (Roy. Soc., Proc. Ser. A. 86. pp. 43–56, Dec. 22, 1911.)—For Part I. see Abstract No. 617 (1911).

710. *Absorption Spectra of Iodine Derivatives of Benzene and Toluene.* **J. E. Purvis.** (Chem. Soc., Journ. 99. pp. 2318–2325, Dec., 1911.)

711. *Line Spectrum of Nitrogen in a Geissler Tube.* **C. Porlezza.** (Accad. Lincei, Atti, 20. pp. 642–645, Dec. 3, 1911.)—Continuing his investigation of this subject [Abstract No. 47 (1912)], the author now gives the wave-lengths and intensities of the lines found by himself and previous observers between the blue and ultra-violet regions of the spectrum, *i.e.*, between $\lambda = 4895$ and $\lambda = 3184{\cdot}14$. W. H. Si.

712. *Theory of the more complicated Zeeman-effects.* **W. Voigt.** (Ann. d. Physik, 36. 5. pp. 873–906, Dec. 21, 1911.)—Mathematical.

713. *Grating with Asymmetrical Screens.* **M. Wolfke.** (Ann. d. Physik, 37. 1. pp. 96–102, Dec. 29, 1911.)—Mathematical treatment of this special kind of diffraction grating. [See Abstract No. 616 (1911).] E. H. B.

714. *Fresnel's Principle and Wave-motion in Gases.* **A. Lechner.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1401–1407, Oct., 1911.)—Mathematical.

715. *Photochemical Processes in Gelatine-Ag Br Plates.* **A. P. H. Trivelli.** (Jahrbuch d. Radioakt. 8. pp. 334–388, Nov. 16, 1911.)—A condensed and critical *résumé* of all the more recent views as to the changes effected by light in the photographic plate. The subject is arranged thus: (1) Introduction; (2) The constitution of the visible products of photochemical action on silver haloids; (3) The blackening curve; (4) The theory of multiple subhaloids; (5) The latent image; (6) Anomalous latent images; (7) The so-called multiple reversals of solarisation. A. D.

716. *A Characteristic of Spectral Energy Curves.—A Correction.* **W. W. Coblentz.** (Phys. Rev. 32. pp. 591–592, June, 1911.)—A correction to an earlier published solution for $\lambda_{max.}$ in Planck's spectral energy equation. (Ibid. 29. p. 553, 1909.)

717. *Emission Spectra of Aromatic Compounds in Ultra-violet Light, Kathode-, Radium-, and Canal-Rays.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 14. 1. pp. 33–42, Jan. 15, 1912. Phys. Zeitschr. 13. pp. 188–193, March 1, 1912.)—A description of research on various substances exposed to the various radiations named above, and tending to show that the spectral phenomena observed indicate a material change of the substance under the action of the rays. The paper does not admit of brief abstract. [See also Abstract No. 44 (1911).] A. W.

718. *Relation between Atomic Volumes and the Spectra of Elements.* **R. Rossi.** (Phil. Mag. 22. pp. 922–925, Dec., 1911.)

719. *Zeeman-effect and Theory of Ritz.* **R. Fortrat.** (Le Radium, 8. pp. 456–458, Dec., 1911.)—In this paper is given a simple method of establishing the formulæ of Ritz without using Lagrange's equations, which are too abstract to show clearly the mechanism by which the exterior magnetic field can modify the vibration of the electron. Various approximations are made, which are discussed. A. W.

720. *Energy of Scattered X-radiation.* **C. G. Barkla.** (Phil. Mag. 21. pp. 648–652, May, 1911.)

721. *Radio-activity of the Tyrolean Mineral Springs.* **M. Bamberger** and **K. Krüse.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 989–1005, June, 1911.)

722. *Radium Emanation contained in the Air of Various Soils.* **J. Satterly.** (Cambridge Phil. Soc., Proc. 16. Part 4. pp. 336–355, Dec., 1911.)

723. *Radio-activity of Marsh Gas.* **J. Satterly.** (Cambridge Phil. Soc., Proc. 16. Part 4. pp. 356–359, Dec., 1911.)

724. *On the Radium Content of Various Fresh and Sea Waters.* **J. Satterly.** (Cambridge Phil. Soc., Proc. 16. Part 4. pp. 360–364, Dec., 1911.)

725. *Emanation Content of Sea Water and Induced Activity of the Air near the Chilean Coast.* **W. Knoche.** (Phys. Zeitschr. 13. pp. 112–115, Feb. 1, 1912.)

726. *Radio-activity of the Dürkheim Mineral Springs.* **E. Ebler** and **M. Fellner.** (Zeitschr. Anorg. Chem. 72. 3 pp. 233–301, Oct. 19, 1911.)

HEAT.

727. *Apparatus for Liquefying Hydrogen.* **K. Olszewski.** (Acad. Sci. Cracovie, Bull. 1a. pp. 1–27, Jan., 1912.)—The author describes in detail various improvements which he has effected in his own and Travers' apparatus [see Abstracts Nos. 907 (1903) and 1499 (1901)] for the purpose of increasing the efficiency, and he explains the manipulation of the apparatus more fully than he had done before. He makes the upper and lower regenerator coils of 3 or 4 (instead of one) copper tubes, of from 1·2 to 2 mm. internal diam., and he enlarges the diam. of the 4 or 6 lowest turns to 2·5 mm. The spheroidal state of the air, which may cause trouble, seems likely to occur at a temperature about 25° C. above the boiling-point of liquid air. The paper contains also descriptions of a thermostat for very low temperatures (in which liquid hydrogen is fed through a siphon, a double-walled brass tube, 0·2 mm. wall thickness, internal diameters 3·5 and 6 mm., the annular space between the two tubes not being evacuated), and his refrigerating plant in the Chemical Institution at Cracow. H. B.

728. *Cubical Expansion of Fused Silica.* **F. J. Harlow.** (Phys. Soc., Proc. 24. pp. 30–39; Discussion, p. 39, Dec. 15, 1911.)—The author's experiments were made on fused silica in the ranges 0° to 100° C. and 0° to 184° C. by the weight thermometer method. The values obtained are ${}_0S_{100} = 99{\cdot}8 \times 10^{-8}$, and ${}_0S_{184} = 144{\cdot}7 \times 10^{-8}$. No permanent change in the volume of the bulb occurred through heating, thus confirming the utility of fused silica for thermometric purposes. In the *discussion*, **H. L. Callendar** said that he did not consider that the cubical coefficient could be deduced satisfactorily from the linear, because it was impossible to anneal a bulb properly, owing to the rapid devitrification of amorphous silica at 1000° C. L. H. W.

729. *Thermal Expansion of Mercury.* **K. Scheel** and **W. Heuse.** (Deutsch. Phys. Gesell., Verh. 14. 3. pp. 139–144, Feb. 15, 1912. Communication from the Physikal.-Techn. Reichsanstalt. Phil. Mag. 23. pp. 412–417, March, 1912.)—Chappuis' determination [see Abstract No. 636 (1908)] depends on the assumption that the cubical expansion of *verre dur* is 3 times that of the linear expansion. Callendar and Moss considered this assumption of isotropy unjustifiable, and they made an absolute determination [Abstract No. 491 (1911)], but the results departed considerably from the direct and indirect determination of Chappuis', also from the absolute determination of Thiesen, although all these are in clear agreement with one another. Recently Harlow [see preceding Abstract] has found the linear expansion of fused quartz in a weight thermometer by using the Callendar and Moss values for the expansion of mercury, and dividing out by three. This result differs considerably from one determination by Chappuis, three determinations of Scheel, and one determination by Holborn and Henning. The authors therefore conclude that some errors have crept into the results of Callendar and Moss. P. E. S.

730. *Fusion of Pure Quartz.* **Billon-Daguerre.** (Comptes Rendus, 154. pp. 506–507, Feb. 19, 1912.)—The quartz is powdered and heated in a carbon crucible in an electric furnace, consisting of three converging electrodes fed by three-phase currents from a transformer for a primary voltage of 6000, and secondary of 70 volts and 1000 amps. The heat is slowly raised up to 1800° C.; the soft quartz is then withdrawn in the shape of sticks and completely fused in the oxy-hydrogen blowpipe. Fluorspar, agate, &c., are similarly treated. No details are given. H. B.

731. *Specific Heat of Binary Mixtures.* I. **A. Schulze.** (Deutsch. Phys. Gesell., Verh. 14. 4. pp. 189–210, Feb. 29; 5. pp. 258–274, March 15, and 6. pp. 344–355, March 30, 1912.)—The mixtures investigated are: Benzol—ethylene chloride, ethyl ether—chloroform, acetone—chloroform, benzol—chloroform, and benzol—ethyl ether. Only the first behaves as an ideal mixture (at 50°); the others all show, at low temperatures, too large values for the molecular and specific heats. L. H. W.

732. *Condensation of Water-vapour by Expansion in an Atmosphere of* CO_2. **E. Besson.** (Comptes Rendus, 154. pp. 342–345, Feb. 5, 1912. *Errata*, p. 548, Feb. 19, 1912.)—In these experiments with CO_2 the photographic method is applied, otherwise the experiments are similar to those carried out by C. T. R. Wilson with air containing water-vapour. The CO_2 gas is obtained by the decomposition by heat of potassium bicarbonate. With expansions up to 1·25 no deposit occurs, and only a very few drops with an expansion of 1·30. A trace of air lowers the expansion necessary to produce condensation. A comparison of the results, contained in the two tables given, shows that when precautions are taken to eliminate all traces of air the inferior and superior limits of the expansion are raised in the case in which the gas is not previously ionised. When the gas has been previously ionised the first appreciable small rain occurs with an expansion of 1·324, while for air the required expansion is 1·25. The limiting expansion thus varies with the gas even when the condensation is produced under the action of Röntgen rays. A. E. G.

733. *Energy-content of Bodies.* **L. Natanson.** (Acad. Sci. Cracovie, Bull. Ser. A. pp. 95–103, Feb., 1912.)—The gradual development of Planck's theory of radiation into its wider aspect in which it must in the future dominate the entire range of molecular science is one of the fundamental contemporary advances of natural knowledge. It is scarcely possible to resist the conviction that Einstein's application of Planck's principles to the calculation of specific heats is a step of overwhelming importance, being nothing less than the laying down of one of the precise foundations of a general theory of matter. There is, however, one prominent and persistent distinction in the very upbuilding of Planck's theory of radiation and Einstein's conception of the nature of the energy contained in material bodies. In the theory of radiation, as is well known, we begin by admitting that to secure equilibrium the presence of a system of vibrators is required, opening up paths of interchange between the energies of different ranges of wavelengths. But when we speak of such a system we do not in any sense imply that from the consideration of the ultimate state of equilibrium alone we shall be able to obtain complete knowledge of its constitution. So long, indeed, as we confine ourselves to the investigation of steady distributions, the law according to which the periods of free vibration are distributed in the system will remain undeterminate. It is true that out of the vibrators present in a material body a vast majority usually fail to receive any share whatever of the energy allotted to the body, so that the number of vibra-

tors of any given frequency must of necessity be much greater than the number of elementary units of energy which they are able to hold. But if this condition is fulfilled, the number of vibrators of any given frequency is not otherwise restricted, and there is nothing to determine the relative proportion in which they must present themselves. The point to which attention is here directed is the fact that in the theory of equilibrium of ideal radiation we have as little as possible to do with the fictitious vibrators; we can regard them simply as an apparatus of representation, useful in allowing us to eliminate the investigation of the details of interaction taking place between matter and the ether. But we cannot long continue to neglect all consideration of them when, with Einstein, we suppose that every material body consists of an assemblage of Planckian vibrators, the energy of which constitutes heat as it exists in hot bodies. If we are to adopt this theory we must be prepared to investigate whether, in the case of actual material substances, there is any law according to which the frequencies of the various admissible modes of vibration are concentrated about their mean value. We are, of course, at liberty to consider any imaginary system we please, and we might conceivably start by confining our attention to a system of vibrators all exactly alike, or to any other ideal system capable of simple analytical specification. But with reference to the actual conditions of nature such arbitrary conceptions are of little utility; they will probably resemble the real cases before us in so few points that we should probably go astray in trusting to them. A generalised mathematical theory is then developed which leads to the same results as were previously obtained by another method. It is finally pointed out that a fundamental desideratum, on Einstein's conception, is the determination of the relative number of vibrators in the groups into which we can distribute them according to the period of their natural vibration. It is admitted that there are considerable difficulties in the way of a complete solution of this problem. E. H. B.

734. *Comparison of the Resistance Thermometer Scale with the Nitrogen Scale from 300° to 630°.* **H. C. Dickinson** and **E. F. Mueller.** (Washington Acad. Sci., Journ. 2. pp. 176–179, April 4, 1912.)—The authors have compared the resistance thermometer scale with the nitrogen scale. The temperatures, reduced to the thermodynamic scale, were compared with those found by Day and Sosman by transfer with thermo-couples. The temperatures obtained by transfer by resistance thermometer and by thermo-couples are in agreement, but there is a difference of 0·17° between the transfer and the direct determination at the boiling-point of sulphur. The best value for the temperature of the boiling-point of sulphur is 444·6° to the nearest 0·1° on the thermodynamic scale. A. F.

735. *Planck's Energy Quantum and its General Importance in Molecular Physics.* **A. Sommerfeld.** (Phys. Zeitschr. 12. pp. 1057–1068; Discussion, pp. 1068–1069, Dec. 1, 1911. Paper read before the 83. Naturforscherversamml., Karlsruhe. Deutsch. Phys. Gesell., Verh. 13. 23. pp. 1074–1093, Dec. 15, 1911.)

736. *Gas Equilibria.* **F. E. C. Scheffer.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 743–758, Feb. 22, 1912.)—Using the recent investigations of Einstein and of Nernst and Lindemann with regard to the variation of specific heat with temperature, the author calculates the constant of entropy in the equation for gas equilibrium. The paper is not suitable for abstraction. A. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

737. *Effect of Electricity on Streams of Water-drops.* **E. F. Burton** and **W. B. Wiegand.** (Phil. Mag. 23. pp. 148–165, Jan., 1912.)—A research partly experimental and partly theoretical. The experimental part is illustrated by instantaneous photographs of water-drops and jets. The theoretical part shows that we may expect to have in the stream drops large and small bearing charges of same sign of almost any ratio, or charges of opposite sign; and that as a consequence there may be, in general, attractions at small distances and repulsions at great distances. E. H. B.

738. *Electronic Charges from Nuclei.* **K. Przibram.** (Phys. Zeitschr. 13. pp. 106–108, Feb. 1, 1912.)—Describes experiments initiated to make a new determination of the electric charge by magnesium vapour. Full details are to be published later. [See Abstracts Nos. 536 (1911), 57 and 354 (1912).] E. H. B.

739. *Review of the Methods used in Determining "e."* **R. Pohl.** (Jahrbuch d. Radioakt. 8. pp. 406–489, Nov. 16, 1911.)

740. *Electrodynamics of Moving Bodies.* **C. Kraft.** (Acad. Sci. Cracovie, Bull. pp. 596–619, Dec., 1911. Extract.)—A highly analytical treatment of problems on the electromagnetic vectors in moving bodies according to Minkowski's fundamental equations. [See Abstract No. 291 (1912).] E. H. B.

741. *Diffraction of Electromagnetic Waves at a Perfectly Conducting Spheroid.* **K. F. Herzfeld.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1587–1615, Nov., 1911.)—Mathematical. E. H. B.

DISCHARGE AND OSCILLATIONS.

742. *Mobility of Ions.* **M. Reinganum.** (Phys. Zeitschr. 12. pp. 575–580, July 15, and pp. 666–671, Aug. 15, 1911.)—A comparison between theory and experimental results, from which the conclusion is drawn that in all probability the gasions have normal molecular magnitudes, but that in view of the origin of the attraction of the ions which is here assumed, the forces are, especially in the case of the light ions, only incompletely given up again. L. H. W.

743. *Interdiffusion of Gases and Velocity of Ions under Electric Force.* **J. S. Townsend.** (Roy. Soc., Proc. Ser. A. 86. pp. 197–206, Feb. 28, 1912.)—The formulæ for K, the coefficient of interdiffusion of gases, and U, the velocity of particles acted upon by an external force, in terms of the mean free path and of the velocity of agitation, are not satisfactory; the ratio between these having about one-half the value, Ne/Π, derived from Maxwell's equations of motion (N = number of mols. per cm.^{3} at pressure Π, and e = the charge on an ion). Assume that the molecules travel with a constant velocity V of agitation equal to the mean value of their velocity (error introduced thereby does not exceed 12 : 13). The mean square of the paths is

twice the square of the mean free path (a result frequently neglected). Assume that after a collision all directions of motion are equally probable, and that the velocity of the ion under electric force is small compared with V. Then the velocity U in the direction of the force is $Xe\,.\,t/m$ (as against Drude's and J. J. Thomson's $\frac{1}{2}.Xe\,.\,t/m$), where $t = l/V$ is the average time between two collisions. Under similar conditions the rate of variation of the mean square of the distance of any distribution from any point is constant, and $= 6K$, where K is the coefficient of diffusion: and $K = \frac{1}{3}lV$; whence $U/K = Xe/m\,.\,l/V.\,3/lV = Ne/\Pi$, since $X = 1$ and $\Pi = \frac{1}{3}mnV^2$. These assumptions therefore give the correct ratio. In the case of the particles diffusing into the gas, being (ions) larger than the molecules of the gas, we can assume that all directions of motion become equally probable only after a large number of collisions. In such a case, if λ be the average (projected) distance the ion travels, after a collision, in the direction in which it was moving before the collision, then $K = \frac{1}{3}(l + \lambda)V$; and under the same conditions $U = Xe/m\,.\,(l + \lambda)/V$; so that the ratio U/K is the same as before, NeX/Π, and is thus independent of the precise definition of the collisions. The term $(l + \lambda)$ is perfectly definite, $= L$; but l and λ will depend on the nature of the collisions. The rate of diffusion of two gases is independent of the number of molecules of each gas present per cm.^{3}, and is inversely proportional to the total pressure of two gases; and the rate of diffusion of a small number of molecules A into a gas B is the same as that of a small number of molecules of gas B into gas A containing the same large number of molecules per cm.^{3}. After collision between a molecule and an ion, then (analogy of small and large sphere, perfectly elastic and smooth), all directions of motion are equally probable in the former; whence it would follow that $(l + \lambda)/l = m/m'$, where m is the mass of the ion and m' that of a molecule; and that u, the velocity of ions when an electric force is also acting as well as diffusion, is $-K/n\,.\,dn/dx + Xe/m\,.\,L/V$; or $pu/K = -dp/dx + nXe$, where p is the partial pressure of the ions, $= \frac{1}{3}mnV^2$. Therefore, if we make the same assumptions in calculating the two quantities involved, the known general equations of motion of particles through a gas follow immediately from the expressions for the rate of diffusion and the velocity under an electric force.

A. D.

744. *Criticism of Steubing's Work on the Radiant Emission from the Spark.* **R. W. Wood.** (Phys. Zeitschr. 13. pp. 32–34, Jan 1, 1912.)—The author has previously found a new kind of emission at the side of the electric spark in the spark discharge [see Abstract No. 120 (1911)]. Steubing, who has repeated some of the experiments, came to the conclusion that this phenomenon is due to the scattering of the light by small metallic particles [Abstract No. 1888 (1911)]. In the present paper Wood upholds the former view. A. E. G.

745. *Photographic Investigation of the Forms assumed by the Brush Discharge in Air at Reduced Pressure.* **C. W. Raffety.** (Röntgen Soc., Journ. 7. pp. 100–107; Discussion, pp. 107–108, Oct., 1911.)

ELECTRICAL PROPERTIES AND INSTRUMENTS.

746. *Electrical Conductivity of Copper-Arsenic Alloys.* **N. A. Pushin** and **E. G. Dishler.** (Jurn. Russk. Fisik-Chimičesk. Obščestva, 44. pp. 125–132, 1912.)—The addition of arsenic to copper causes a rapid increase in the specific resistance (in ohms) from $1{\cdot}708 \times 10^{-6}$ at 25° (or $1{\cdot}588 \times 10^{-6}$ at 0°)

to $85{\cdot}0 \times 10^{-6}$ at 25° ($84{\cdot}8 \times 10^{-6}$ at 0°) for a content of 6 per cent. of As. At this point the curve of resistance suddenly changes its direction, the resistance continuing to increase, but more slowly, to $68{\cdot}0 \times 10^{-6}$ at 25° ($59{\cdot}0 \times 10^{-6}$ at 0°) for 28·5 per cent. of As. With higher proportions of As, the specific resistance gradually diminishes to the value $52{\cdot}6 \times 10^{-6}$ at 25° ($49{\cdot}8 + 10^{-6}$ at 0°) for 42 per cent. of As. Attempts to prepare Cu-As alloys containing more than about 44–45 per cent. As resulted in volatilisation of the excess of As. These results are not in agreement with those of Friedrich [Abstract No. 812 (1909).] It has been shown by various authors that: (1) For mechanical mixtures, the electrical conductivities of alloys and their temperature-coefficients are additive in character; (2) when solid solutions are formed, the conductivity and its temperature-coefficient diminish as the concentration of the solid solution increases; (3) an intermetallic compound possesses a characteristic conductivity peculiar to it; (4) the temperature-coefficient of the conductivity of such a chemical compound differs little from that of pure metals. Consideration of the melting-point diagram of the system Cu-As given by Friedrich (*loc. cit.*) and of the resistance curve obtained by the author, shows that these two metals form a solid solution with a maximum concentration of 6 per cent. of As. The proportion of 28·2 per cent. of As corresponds with the compound Cu_3As, which also occurs naturally as domeykite. No indication is given by the curves of the existence of a compound, Cu_5As_2, and the constancy of the temperature-coefficient of conductivity in the region 28·5–42 per cent. As indicates the absence of any solid solution. Tempering causes little change in the resistance of Cu-As alloys poor in As, but is accompanied by an increase of 60–70 per cent. in the resistance of those containing 32 per cent. and upwards of As; this phenomenon is probably due to a profound change in the chemical nature of the alloys. T. H. P.

747. *Resistance of Mercury near Absolute Zero.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 818–821, Feb. 22, 1912.)—By the use of a bath of liquid helium the resistance of mercury was measured in the neighbourhood of 4° K. [see Abstract No. 1042 (1911)]. From 4·4° down to 4·21° the resistance is only slowly decreasing, but between 4·21° and 4·19° K. the resistance diminished very rapidly and practically disappeared at 4·19° K. Temperature measurements are here given with 4·25° K. as the boiling-point of helium. E. H. B.

748. *Conductivity of Antimony-Cadmium Alloys.* **A. Eucken** and **G. Gehlhoff.** (Deutsch. Phys. Gesell., Verh. 14. 3. pp. 169–182, Feb. 15, 1912.)—The Sb-Cd alloys possess high thermo-e.m.f.'s, and the conductivities for heat and electricity of various alloys of these metals of different percentage composition have been measured by the authors at temperatures of 0°, −79°, and −190° C. The relation between the conductivities and the changes which occur with change of temperature are set out in curves and in tables. The differences of the heat conductivities of the alloys is very great. The heat conductivity of the compound SbCd at 0° is extremely small, being only slightly greater than that of window glass. The high negative temperature-coefficient of the heat conductivity of this compound leads to the conjecture that here the transport of heat is in only a small degree by means of the electrons, but rather is due to the same hitherto little-known causes which operate in the case of non-conducting crystals. The influence of composition on the electric conductivity is far greater than on the conductivity for heat. The ratio of the conductivity of Cd to that of the compound SbCd is for heat 77·5, for electricity 6445 (at 0° C.). The heat conductivity and the temperature-coefficient both have for the compound SbCd a singular point. The ratio of the heat conductivity to the electric conductivity also shows a singular point for the compound. The value of this ratio is very high. The course of the thermo-e.m.f. is analogous to that of the ratio of the conductivities for heat and electricity in the case of the alloys with varying proportions of Sb and Cd. J. J. S.

749. *Electrometer Shunt.* **M. Dieckmann.** (Phys. Zeitschr. 13. pp. 108–112, Feb. 1, 1912.)—Just as a large current may be estimated by a delicate galvanometer when shunted, so may a high potential be estimated by a delicate electrometer when "shunted," as it is here termed. The arrangement in question consists of two condensers (one of which is variable) in series in the main circuit, the electrometer being connected to the terminals of one of them. E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

750. *Initial Susceptibility of Nickel at Low Temperatures.* **A. Perrier** and **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 1004–1007, March 28, 1912. Communication No. 126a from the Phys. Lab., Leiden.)—Employing five fields between 0·017 and 0·090 gauss on a nickel toroid, the authors obtain the following values for the initial susceptibility of nickel: At 291° abs., 3·045; at 90° abs., 0·955; at 76·5° abs., 0·881; at 25·5° abs., 0·782. These results are in satisfactory harmony with those obtained by Radonavovitch for temperatures above 0° C. A. D. R.

751. *Magnetic Susceptibility and Magneton Number of the Oxides and Sulphides of Vanadium.* **E. Wedekind** and **C. Horst.** (Ber. Deut. Chem. Gesell. 45. pp. 262–270, 1912.)—The specific magnetic susceptibility, χ, and the magneton number $n = \sigma m/1128{\cdot}5$, where σm is the molecular saturation of the various compounds are as follows :—

	VO.	V_2O_3.	VO_2.	V_2O_5.	VS.	V_2S_3.	V_2S_5.	VOCl.	VN.
$\chi \times 10^{-6}$	50·06	13·88	3·73	0·86	7·22	8·95	12·55	27·16	4·13
n	13·90	10·92	4·19	2·99	5·86	10·00	11·90	13·18	3·92

It is noteworthy that whilst the magnetic susceptibility decreases from the monoxide to the pentoxide, it increases from the monosulphide to the pentasulphide. The second component may thus exert a decisive influence on the susceptibility of simple compounds of paramagnetic metals. The curve showing the relation between the magnetic susceptibility and (*a*) the sulphur-content is a straight line on which the point for vanadium itself lies; (*b*) the oxygen-content has a break corresponding with the position of each oxide. The magneton numbers differ very little from whole numbers, and increase or decrease with the susceptibility, without proportionality existing; they are smaller than those which have been found for chromium, manganese, or iron salts. Special methods of preparation of vanadium monoxide and monosulphide are given. T. S. P.

752. *Magnetic Temperature-coefficients of Ferromagnetic Elements.* **J. R. Ashworth.** (Phil. Mag. 23. pp. 36–45, Jan., 1912.)—When a magnet is taken repeatedly through a definite cyclic variation of temperature, the magnetic intensity finally becomes cyclic and without hysteresis. If the dimension-ratio is large, so that the demagnetising factor is negligible, the temperature coefficient is then a minimum and characteristic of the material. It is large for nickel, small for iron, and smaller still for cobalt. The author has investigated magnetometrically how the characteristic temperature-coefficients are related to the critical temperatures of these ferromagnetics. The critical temperature is taken as the point where the magnetic intensity varies most rapidly with temperature, viz., 388° C. for Ni, 785° for Fe, and 1090° for Co. Plotting (I/I_0) against (θ/θ_1), where I/I_0 is the magnetic intensity calculated as a fraction of the estimated intensity at 0° abs., and θ/θ_1 is the ratio of the temperature θ° abs. to the critical temperature θ_1° abs., the curves for the three elements are practically coincident. This shows that the characteristic temperature-coefficients of magnetic intensity of the pure annealed ferromagnetic elements in corresponding states are inversely proportional to the absolute critical temperatures. This result is precisely the law for change of density of liquids with variation of temperature, and the temperature coefficients are very nearly of the same magnitude. A. D. R.

753. *Kerr Magneto-Optic Effect in Compounds and Alloys.* **S. Loria.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 970–983, March 28, 1912.) —This is an extension of the work described in Abstract No. 991 (1910). The Kerr polar rotation has been examined in its dependence on the wave-length of the light and on the intensity of the magnetic field, in magnetite, hæmatite, manganese, nickel, and iron-nickel alloys. The measurements extend over the region of the spectrum between 436 $\mu\mu$ and 681 $\mu\mu$, and with fields from 0·9 to 21 kilogauss, and tables are given of the results. Of chief interest is the result that the non-magnetic 25 per cent. nickel-steel is optically active, giving a negative rotation throughout the visible spectrum. 27 per cent. nickel-steel which is practically non-magnetic gives a much larger rotation than rather strongly magnetic nickel-steels. Taken in conjunction with the behaviour in this respect of Heusler's alloy, the result is one of great interest in the theory of alloys although its physical interpretation is very difficult. A. D. R.

754. *Clinical Significance of X-ray and Radium Measurements.* **S. Russ.** (Röntgen Soc., Journ. 8. pp. 35–40; Discussion, pp. 40–41, April, 1912.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

755. *Monatomicity of Neon, Krypton, and Xenon.* **W. Ramsay.** (Roy. Soc., Proc. Ser. A. 86. pp. 100–101, Jan. 31, 1912.)—When the author's memoir on argon and its companions [see Abstract No. 2415 (1901)] was written, it was stated that no experiments with the pure gases had been carried out on the ratio between the specific heat at constant pressure and constant volume, but that measurements made with impure samples indicated the ratio 1·67. The author has now determined the ratio for the above gases, using relatively large quantities of the pure gases. The method adopted was similar to the one previously described, the wave-length of sound in the gas under investigation being compared with that in air by Kundt's method. Taking the densities as follows: air 14·479, neon 10·10, krypton 41·46, xenon 65·11, the ratios obtained were for neon, 1·642; krypton, 1·689; xenon, 1·666. Hence the three elements must be regarded as monatomic. A. W.

756. *Mechanics of the Water Molecule.* **R. A. Houstoun.** (Roy. Soc., Proc. Ser. A. 86. pp. 102–105, Jan. 31, 1912.)—From considerations of the absorption spectrum of water and water-vapour the author has devised a model of the water molecule, which is described and tested numerically as regards the ratio of the wave-lengths of the absorption bands and as regards the value of e/m. A fair agreement, considering the simplicity of the assumptions, is obtained. A. W.

757. *Heat of Combustion of a Molecule and its Chemical Attraction Constant.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 16. Part 4. pp. 299–312, Dec., 1911.)—In previous papers the author deduced from surface tension and latent heat data the law of attraction between molecules that corresponds to the attraction which is large in comparison with gravitation for small distances of separation of the molecules [see Abstract No. 1675 (1910)]. It is very probable that the law obtained holds for closer distances of separation of two atoms or molecules than the distance of separation of the molecules in a liquid. The attraction represented by the law would then be the only one operating when chemical combination takes place. If that is the case we would expect that relations exist between the chemical quantities connected with substances and the attraction constants of the atoms of their molecules. Such relations exist; a number have already been pointed out in a previous paper [Abstract No. 290 (1912)]. Further relations are now given. It should be mentioned that these relations can only as yet be found by trial. It is found that the heats of combustion of the hydrocarbons are approximately proportional to $\Sigma\sqrt{m_{\mathrm{HC}}}$, which denotes the sum of the square roots of the atomic weights of the atoms of a molecule, and is therefore its attraction constant. The ratio of the heat of combustion H_c to the quantity $\Sigma\sqrt{m_{\mathrm{HC}}}$ is approximately constant; its mean value is 29·5. L. H. W.

758. *Development of Crystal Faces.* **P. Gaubert.** (Nature, 88. p. 360, Jan. 11, 1912. Abstract of Memoir published by the Soc. de Chimie physique.)—Colouring matters, such as methylene blue, eosine, fuchsine, and picric acid are capable of passing into the crystal substance in two different ways. When

the solution is saturated with the colouring matter this is deposited on the crystal in the course of growth. Thus lead nitrate when pure usually deposits colourless octahedral crystals; but when the mother liquor is saturated with methylene blue the crystals exhibit cube faces modifying those of the octahedra, and these cube faces alone are coloured blue; they also exhibit striations like pyrites, corresponding to the faces of the pentagon-dodecahedron. The colour thus not only attaches itself to the faces of a particular form, but indicates the true class of symmetry of the system, in this case a class lower than the holohedral. Similar phenomena are described with gypsum, copper sulphate, thallium sulphate, and morphine, all of which develop unusual forms and faces, coloured by the dye, when the latter is methylene blue. Strong polychroism is also introduced in the case of copper sulphate. The second mode of coloration occurs when a dye stains the crystals grown whatever be the state of dilution of the dye. Thus nitrate of urea usually crystallises in monosymmetric tables parallel to the basal plane, bounded by a prism and pinakoids. But when methylene blue is present the latter are suppressed and the plates are coloured blue and elongated along the axis of the prism. If, however, picric acid be used as the colouring matter the pinakoids are developed, but not the prism. When both methylene blue and picric acid are present the crystals of urea nitrate show all four forms, and the plate shows eight sectors, four coloured blue, corresponding to the prism faces, and four yellow opposite the pinakoid faces. Phthalic acid exhibits analogous phenomena with methylene blue, malachite green, and scarlet of Biebrich, specific forms staining with each dye, and the crystal showing differently-coloured sectors when the dyes are simultaneously present. T. M. L.

759. *Atomic Weight of Radium.* **O. Hönigschmid.** (Akad. Wiss. Wien, Ber. 120. 2a. pp. 1617–1652, Nov., 1911.)—The author discusses in detail the method used by Mme. Curie in determining the atomic weight of Ra. She found as the mean of three very concordant determinations a value 226·45. It is pointed out that there are several places in her method of procedure where inaccuracies might arise, the general effect of which would be to give too high a value for the atomic weight. The author has made very pure preparations of $RaCl_2$ by repeated crystallisation of the salt from HCl and by precipitation of the salt from aqueous solution with alcohol. The purity of the product was tested by atomic weight determinations. At a certain point in the purification it was found that the atomic weight of the product reached 225·9. Recrystallisation fifty times and precipitation with alcohol eleven times did not alter this figure, the atomic weight determined at every intermediate stage being the same. This preparation was therefore assumed pure. The atomic weight was determined in two ways: by the ratio of AgCl to $RaCl_2$, and the ratio Ag to $RaCl_2$. The radium salt was always weighed as fused chloride. As a mean of many determinations the value 225·95 ± 0·02 was found. Five standard preparations of $RaCl_2$ were prepared from the pure salt varying in amount from 10 to 680 mgm. A standard radium solution was also made. E. M.

760. *Slowness of Recombination of the Ions produced in some Chemical Reactions.* **H. J. Proumen.** (Bull. Soc. Chim. de Belgique, 24. pp. 209–210, 1910.)—The author has found that the ions which are formed in processes of combustion with an insufficient supply of oxygen can be detected after as long a period as 2 hours after the flame has been extinguished. It is con-

sidered probable that it is the charged solid particles (which behave as large ions) present in the products of combustion, which give rise to their property of discharging an electroscope. L. H. W.

761. *Alloys of Radium and Electro-deposited Radium.* **F. de Mare** and **C. Jacobs.** (Bull. Acad. Roy. Belg. pp. 53–54, 1912.)—The author has obtained a yellowish-white Ag-Ra alloy of marked radio-active power by heating a mixture of radium sulphate, silver chloride, calcium carbonate and carbon in a Fletcher furnace. In another experiment he obtained an active brown electrolytic deposit on electrolysing a solution of radium acetate, using Pt electrodes. It was further found that while the α-, β-, and γ-rays do not pass through quartz, the luminous radiations from a radium salt do so. L. H. W.

762. *Copper Amalgam.* **A. Guntz** and **de Greift.** (Comptes Rendus, 154. pp. 357–358, Feb. 5, 1912.)—The electrolysis of copper sulphate by means of a mercury kathode yields an amalgam which, compressed in a leather bag, contains 17 per cent. of Cu; this percentage is raised to 24·10 (corresponding to HgCu) by applying a pressure of 6250 kg./cm.^{2}. When the amalgam is prepared by heating the two metals and squeezed out in the same way, the Cu percentage rises finally to 97. The amalgam HgCu seems to be decomposed at 135°, and the amalgam prepared by heating to be unstable at first, but slowly to pass into a stable solution of amalgam in mercury. H. B.

763. *Effect of Metallic and Non-metallic Additions on Normal Copper-Tin Bronze.* **H. v. Miller.** (Metallurgie, 9. pp. 63–71, Jan. 22, 1912.)—It is well known that small quantities of various metals and metalloids exert a favourable influence on many of the properties of bronzes, and the author has studied their effect on an art bronze containing 8 per cent. tin. Contraction and cooling curves were obtained in an apparatus similar to that of Wüst [Abstract No. 500 (1910)]; tensile and machining tests were carried out on the cooled bars, while the ability to develop a patina was tested by comparing the effects produced by treating the alloy and the standard bronze with a dilute solution of ammonium polysulphide. One of the most disagreeable properties of bronze is the relatively large contraction on cooling. This is only appreciably diminished by the addition of 10 per cent. of Zn, while Co, Al, Si, Fe, and Ni increase the coefficient of contraction. The tensile strength is increased by Co, Ni, and Mn, but decreased by Sb and Zn. Machining operations are facilitated by Sb and Pb (up to 2 per cent.), but rendered more difficult by Mn and Ni. The formation of a patina is intensified by the addition of Co, Ni, Sb, Fe, Si, and P, but diminished by Zn and Al. W, Ni, Fe, Mn, and Co increase the solidification-point of bronze to a considerable extent. F. C. A. H. L.

764. *Annealing of Metals.* **Matweeff.** (Rev. de Métallurgie, 8. pp. 708–716, 1911. Metallurgie, 9. pp. 173–175, March 8, 1912.)—Samples of various metals and alloys were cold-hardened by hammering and annealed at various temperatures. After each stage the Brinell hardness number was determined using a glass ball 1 mm. in diam. and a pressure up to 5 kg. The results show that cold hardness is only lost after annealing at a certain temperature which varies for different metals, *e.g.*, 100° for Zn, 300° for Cu, and 350° C. for Al. Impurities change the hardness of the annealed metal and the temperature of the change, and increase the temperature interval required for complete annealing. F. C. A. H. L.

765. *Crystallisation and Subsequent Transformations in Irons containing over Four Per Cent. of Carbon.* **N. M. v. Wittorf.** (Jurn. Russk. Fisik.-Chimicěsk. Obščestva, 48. pp. 1618–1690, 1911.)—The principal results of this extended thermal and micrographic study of iron-carbon alloys are as follows: Fusions containing 6·2–10 per cent. of carbon begin to crystallise at 2000°–2880°, with separation of a carbon-rich phase (? FeC_2), which in unetched sections has a pale sulphur-yellow colour and a silvery reflection. This phase is etched very slowly by nitric acid (1 : 4), and becomes coated with copper when treated with very dilute copper sulphate solution; after the action of nitric acid a dark residue is obtained. The same carbide crystallises when the fusion is heated to 2600° and the graphite dissolved in it. From somewhat below 2000° down to 1700°, the first substance separating is pure cementite. In the temperature region 1650–1880°, burning of the fusion takes place, this being particularly marked with a carbon-content of about 7 per cent.; stirring of the fusion is accompanied by the appearance of thin, tubular crystals (? FeC) at the surface, whilst in fusions heated to about 1600° these crystals assume the form of long arrows with angular projections. Fusions heated below 1700° always contain a metallic phase surrounding the arrows or a compound rich in carbon (? FeC_2), forming dendritic masses on a eutectic-like foundation. This compound is not appreciably etched by 4 per cent. alcoholic picric acid solution or by aqueous sulphuric acid (1 : 10 by weight) if the mass is hardened at a temperature not below 1160°, but, unlike cementite, it is etched energetically by 1 : 4 nitric acid. The quantity of this compound separating initially increases from 0 to 100 per cent. with increase in the concentration of the carbon from 4·1 to 5 per cent. In fusions containing 6 or 7 per cent. of carbon, the basic mass of metal consists of this compound and of the arrow-like residuum (? FeC), its composition being expressed by the formula Fe_4C (5·02 per cent. C). The carbide, Fe_4C, decomposes into γ-solution and graphite below 1180°. Crystallisation of the stable eutectic in fusions containing more than 4·1 per cent. of carbon proceeds at about 1180°. The phases crystallising above 2000° (? FeC_2) and at 1600–1400° (? FeC) decompose with separation of graphite. The points of disagreement between these results and those of Ruff and of Ruff and Goecke [Abstract No. 1406 (1911)], which were published after the completion of the author's investigations, are discussed. T. H. P.

766. *Crystallisation of α-Iron.* **Ziegler.** (Rev. de Métallurgie, 8. pp. 655–672, 1911. Metallurgie, 9. p. 178, March 8, 1912.)—Just as crystallisation tends to start from solid particles in liquid solutions, it tends to start from enclosures in solid solutions. Above Ar_3 steel is a solid solution of carbon in γ-iron and during the transition temperature ferrite or cementite is deposited on the slag enclosures according as the steel is hypo- or hyper-eutectic. The deposition ceases when the concentration of the solid solution reaches 0·9 per cent. carbon, the residual material forming cells surrounded by envelopes of ferrite or cementite and known as "grains." These envelopes show the size of the pre-existing γ-iron crystals which increase in size with the length of time and the temperature to which the steel is heated above Ar_3. The rate of cooling below Ar_3 does not alter the size of the envelopes, but alters their appearance. Fairly rapid cooling develops plane sides, while, under very slow cooling, the envelopes branch out into the interior of the grains. The ferrite branches are thicker and not so sharp as the cementite branches. The mechanical strength of steel increases with the fineness of the grain size and the extent to which the slag enclosures exist in discontinuous thin layers. F. C. A. H. L.

767. *Electrolytic Reduction of Nitrobenzene.* **R. C. Snowdon.** (Journ. Phys. Chem. 15. pp. 797–844, Dec., 1911.)—As the chemical and electrolytic reductions of nitrobenzene do not proceed on parallel lines, the author reviews both these processes, and he tabulates 49 chemical and 22 electrochemical methods for preparing aniline and 8 derivatives; only 15 of the chemical processes have their parallels in electrolytic methods, and in all these a porous cup is wanted for preventing oxidation at the anode. The author wished to dispense with this cup and also with the use of a Pt anode. The experiments first seemed to prove that neither ferrous chloride alone, nor this chloride in the presence of massive (sheet) iron would reduce nitrobenzene chemically, but that finely-divided iron would do so, which would be in accordance with technical practice; it resulted, however, that with good stirring (or boiling) massive iron would answer. For the electrolytic reduction the nitrobenzene is suspended in ferrous chloride at 100°, and decomposed between sheet-iron electrodes with currents of 2·2 volts and 15 amps./dm.^{2}; too much anode iron is dissolved, and the concentration of the ferrous chloride remains unchanged during the run; with low current-densities the kathode is also attacked, while some iron may be deposited at the kathode. The yield of aniline rises to 95 per cent., calculated on the total iron dissolved; without the electric current iron and ferrous chloride give a yield of 78 per cent. only. High yields are also obtained in some alkaline solutions (sulphide) by chemical methods. H. B.

768. *Electrochemical Oxidation of Hydrazine Salts.* **J. W. Turrentine** and **W. A. Gibbons.** (Amer. Chem. Soc., Journ. 34. pp. 36–49, Jan., 1912.)—The research was undertaken for the purpose of investigating whether the electrolytic oxidation of hydrazine salts would yield other products than the chemical oxidation which Rimini and Browne and Shetterly studied, while Szarvassy had tried electrolysis in 1900. The authors started from a syrup of hydrazine carbonate at —25° or —30° C.; no percarbonate was obtained, the hydrazine being alone oxidised. The electrolysis of hydrazine chloride and bromide with a wire kathode and a foil anode (gauze disc if rotated), both of Pt, yielded in the cold only N and H_2O, in the warm solution also NH_3, but no hydronitric acid. The iodide was not tried, therefore. H. B.

769. *Application of the Electrometer to the Study of Chemical Reactions in Electrolytes.* **M. Boll.** (Comptes Rendus, 154. pp. 349–351, Feb. 5, 1912.)—Deals with measurements of the resistance of electrolytes, &c., using an electrometer as indicating instrument. L. H. W.

770. *Representation of and Conversion of Atomic or Molecular Percentages into Percentages by Weight in Multiple Systems.* **F. Hoffmann.** (Metallurgie, 9. pp. 133–142, Feb. 22, 1912.)—The author describes the various arithmetical, graphical, and combined arithmetic and graphic methods of converting percentages by weight into atoms or mols. per cent, or *vice versâ*, in binary and ternary systems, and illustrates the methods by reference to the Al-Cu-Ag system. F. C. A. H. L.

771. *Diffusion Tests on Metallic Alloys.* **Le Gris.** (Rev. de Métallurgie, 8. pp. 618–625, 1911. Metallurgie, 9. p. 175, March 8, 1912.)—Some methods of preparing alloys whose compositions vary continually from one pure metal to the other are described. F. C. A. H. L.